



# University of Sheffield

## **Identifying malnutrition in emergency general surgery**

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

The University of Sheffield  
Faculty of Medicine, Dentistry and Health  
School of Medicine

August 2024

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## Declaration

I, Daniel Lee Ashmore, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis. Copyright transfers have been obtained for all previously published work arising from this thesis, including permission from co-authors to reproduce the work within this thesis.

## Acknowledgements

I must acknowledge several individuals and organisations that have supported me during my PhD and 'Out of Programme for Research'.

Firstly, I would like to thank my supervisors Mr Matt Lee and Dr Vanessa Halliday. This research would not have been possible without both of you. On deciding to embark on research, I sought advice from many trainee and consultant colleagues across the region. All stressed the importance of a strong supervisory team, and now, I know why. I have been fortunate to be on the receiving end of your expertise, guidance, candour, and humour throughout this research process. You have been the best supervisors I could have asked for. Thank you so much.

I also thank Mr Tim Wilson, who has, in large part, mentored me for the last three years. From initially offering me the Clinical Research Fellow post at Doncaster to critiquing each piece of work I have sent across, your contribution has been invaluable. As well as the surgical skills I have directly learned, you have demonstrated how to be a surgeon who places nutrition at the heart of clinical practice.

Thanks to Mr Adil Rashid for your help with the systematic review, Mr Danny Baker for reviewing the qualitative work, and Miss Jenna Morgan for your methodological knowhow regarding DCEs.

I have been lucky to have worked at Doncaster as a Clinical Research Fellow for three years. As well as accommodating my research commitments, I have worked alongside a fantastic surgical team. There are quite simply too many people to name here. I have learned the importance of having the right colleagues around at work. I will treasure my time at Doncaster; you have all made me feel an integral and valued part of the team. The bar has been set high for my future rotations and consultant post.

Thank you for the research support provided by the Association of Surgeons of Great Britain and Ireland (ASGBI) for three of my studies, as well as the opportunity to present my work at your national conference. I also thank the many surgeons (and anaesthetists) who have given up their precious time to be part of my studies, especially those that were interviewed.

Finally, I would like to thank my wife Hannah. My words will fail to truly express how grateful I am. You have been my sounding board during this process and have kept me grounded. I realise the toll this has had on you, us and our family. Although I will do my best to show you how much it has meant to me, I will be infinitely indebted to you. Thank you for teaching me what is important in life.

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# I Publications, presentations and prizes

## Publications

### Full papers in print in peer reviewed journals

**Ashmore DL**, Baker D, Wilson TR, Halliday V, Lee MJ. Barriers Faced by Surgeons in Identifying and Managing Malnutrition in Emergency General Surgery: A Qualitative Study. Colorectal Disease: The Official Journal of the Association of Coloproctology of Great Britain and Ireland. 2024 Dec 10; Available from: <https://doi.org/10.1111/codi.17261>.

**Ashmore DL**, Wilson T, Halliday V, Lee M. Malnutrition in emergency general surgery: a survey of National Emergency Laparotomy Audit Leads. J Hum Nutr Diet [Internet]. 2024 Mar 4; Available from: <http://dx.doi.org/10.1111/jhn.13293>.

**Ashmore DL**, Rashid A, Wilson TR, Halliday V, Lee MJ. Identifying malnutrition in emergency general surgery: systematic review. BJS Open. 2023 Sep 25;7(5):zrad086.

### Papers submitted to peer reviewed journals

**Ashmore DL**, Wilson TR, Halliday V, Lee MJ. The influence of surgeon seniority and intestinal failure experience on identifying malnourished patients in emergency general surgery: a national survey (Paper 4). Submitted to RCS Annals.

**Ashmore DL**, Morgan J, Wilson TR, Halliday V, Lee MJ. What influences emergency general surgeons' treatment preferences for patients requiring nutritional support? A discrete choice experiment (Paper 5). Submitted to Colorectal Disease.

### Published abstracts

**Ashmore D**, Baker D, Wilson T, Halliday V, Lee M. SP2.7 A Consultant General Surgeon's approach to evaluating malnutrition in emergencies: a qualitative study. Br J Surg. 2024 Sep 9;111(Supplement\_8):znae197.028.

**Ashmore DL**, Lee MJ, Wilson TR. A service evaluation of emergency laparotomy and total parenteral nutrition at a single teaching hospital. Clin Nutr ESPEN. 2024 Jun;61:476.



**Ashmore DL**, Wilson TR, Halliday V, Lee MJ. Current practice and outcomes of malnutrition in emergency general surgery. Clin Nutr ESPEN. 2024 Jun;61:485–6.

**Ashmore DL**, Rashid A, Wilson T, Halliday V, Lee MJ. Identifying malnutrition in emergency general surgery. Clin Nutr ESPEN. 2023 Oct;57:834–5.

**Ashmore D**, Rashid A, Wilson T, Halliday V, Lee M. SP9.10 Identifying Malnutrition in Emergency General Surgery (EGS): A Systematic Review. Br J Surg. 2023 Aug 21;110(Supplement\_6):znad241.107.

**Ashmore D**, Wilson T, Halliday V, Lee M. 352 A National Survey of National Emergency Laparotomy Audit (NELA) Leads to Identify Current Nutrition Practices and Pathways in NELA-Eligible Emergency General Surgery Patients. Br J Surg. 2023 Aug 30;110(Supplement\_7):znad258.063.

## Presentations

### Oral presentations

‘Malnutrition in emergency general surgery: who do we feed and why?’ at BAPEN, 5-6<sup>th</sup> November 2024, Gateshead

‘Barriers faced by surgeons in identifying and managing malnutrition in emergency general surgery: a qualitative study’ (full oral) at NHSE Yorkshire and Humber Academic Presentation Day, 5<sup>th</sup> July 2024, Sheffield

‘What influences emergency general surgeons’ treatment preferences for patients requiring nutritional support? A discrete choice experiment’ (flash oral) at NHSE Yorkshire and Humber Academic Presentation Day, 5<sup>th</sup> July 2024, Sheffield

‘A consultant general surgeons’ approach to evaluating malnutrition in emergencies: a qualitative study’ as a short paper presentation (SP2.7) at ASGBI, 8-10<sup>th</sup> May 2024, Belfast

‘Current practice and outcomes of malnutrition in emergency general surgery’ at BAPEN, 28-29<sup>th</sup> November 2023, Edinburgh

‘Identifying malnutrition in emergency general surgery (EGS): a systematic review’ as a short paper presentation (SP9.10) at ASGBI, 17-19<sup>th</sup> May 2023, Harrogate

‘A national survey of NELA Leads to identify current nutrition practices and pathways in NELA-eligible emergency general surgery patients’ at ASiT, 3-5<sup>th</sup> March 2023, Liverpool

‘A national survey of NELA Leads to identify current nutrition practices and pathways in NELA-eligible emergency general surgery patients’ at York Medical Society Founders Prize (Finalist), 24<sup>th</sup> March 2023, York

‘A national survey of NELA Leads to identify current nutrition practices and pathways in NELA-eligible emergency general surgery patients’ at RCS England and YRSC conference, 2<sup>nd</sup> February 2023, Leeds

## **Poster presentations**

‘The influence of surgeon seniority and intestinal failure experience on identifying malnourished patients in emergency general surgery: a national survey’ at BAPEN, 5-6<sup>th</sup> November 2024, Gateshead

‘What influences emergency general surgeon’ treatment preferences for patients requiring nutritional support? A discrete choice experiment’ at BAPEN, 5-6<sup>th</sup> November 2024, Gateshead

‘Barriers faced by surgeons in identifying and managing malnutrition in emergency general surgery: a qualitative study’ at BAPEN, 5-6<sup>th</sup> November 2024, Gateshead

‘The influence of surgeon seniority and intestinal failure experience on identifying malnourished patients in emergency general surgery: a national survey’ at NHSE Yorkshire and Humber Academic Presentation Day, 5<sup>th</sup> July 2024, Sheffield

‘What influences emergency general surgeon’ treatment preferences for patients requiring nutritional support? A discrete choice experiment’ at NHSE Yorkshire and Humber Academic Presentation Day, 5<sup>th</sup> July 2024, Sheffield

‘How do consultants surgeons identify malnutrition in the emergency setting, what are the barriers and what is the impact for patients? A qualitative study’ at ASiT 2024, 8-10<sup>th</sup> March 2024, Bournemouth

‘A survey of National Emergency Laparotomy Audit (NELA) Leads: malnutrition in emergency general surgery’ at BAPEN, 27-29<sup>th</sup> November 2023, Edinburgh

‘Identifying Malnutrition in Emergency General Surgery (EGS): A Systematic Review’ at NHSE Yorkshire and Humber Academic Presentation Day, 23<sup>rd</sup> June 2023, York

‘A national survey of NELA Leads to identify current nutrition practices and pathways in NELA-eligible emergency general surgery patients’ as a talking poster presentation at ASGBI, 17-19<sup>th</sup> May 2023, Harrogate

‘Identifying Malnutrition in Emergency General Surgery (EGS): A Systematic Review’ at ASiT, 3<sup>rd</sup>-5<sup>th</sup> March 2023, Liverpool

‘Identifying malnutrition in emergency general surgery patients’ at BAPEN, 28-29<sup>th</sup> November 2022, Brighton

## Prizes

### **Oral Presentation Award**

‘Barriers faced by surgeons in identifying and managing malnutrition in emergency general surgery: a qualitative study’ (full oral) at NHSE Yorkshire and Humber Academic Presentation Day, 5<sup>th</sup> July 2024, Sheffield

### **The BAPEN Medical Powell-Tuck Prize**

‘Current practice and outcomes of malnutrition in emergency general surgery’ at BAPEN, 28-29<sup>th</sup> November 2023, Edinburgh.

### **The BAPEN Medical Powell-Tuck Prize**

‘Barriers faced by surgeons in identifying and managing malnutrition in emergency general surgery: a qualitative study’ and ‘What influences emergency general surgeons’ treatment preferences for patients requiring nutritional support? A discrete choice experiment’ at BAPEN, 5-6<sup>th</sup> November 2024, Gateshead.

### **Student Recognition of Achievement Award**

For significant contribution in the field of nutrition. BAPEN, 5-6<sup>th</sup> November 2024, Gateshead

## **Presentations related to but not directly arising from this thesis**

Oral presentation 'A Service Evaluation of Emergency Laparotomy and Total Parenteral Nutrition at a Single Teaching Hospital' at NHSE Yorkshire and Humber Academic Presentation Day, 23<sup>rd</sup> June 2023, York

Poster presentation 'Identifying Malnutrition in Emergency General Surgery (EGS): A Systematic Review' at NHSE Yorkshire and Humber Academic Presentation Day, 23<sup>rd</sup> June 2023, York

Poster presentation 'A service evaluation of emergency laparotomy and total parenteral nutrition at a single teaching hospital' as a talking poster presentation at ASGBI, 17-19<sup>th</sup> May 2023, Harrogate

Poster presentation 'A service evaluation of emergency laparotomy and total parenteral nutrition at a single teaching hospital' at ASiT, 3<sup>rd</sup>-5<sup>th</sup> March 2023, Liverpool

'A service evaluation of emergency laparotomy and total parenteral nutrition at a single teaching hospital' at BAPEN, 28-29<sup>th</sup> November 2023, Edinburgh

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## V List of abbreviations

|            |                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------|
| 3-Min NST  | 3-minute Nutrition Screening Tool                                                                                          |
| AMC        | arm muscle circumference                                                                                                   |
| APACHE II  | Acute Physiology and Chronic Health Evaluation II                                                                          |
| ASA        | American Society of Anesthesiologists                                                                                      |
| ASGBI      | Association of Surgeons of Great Britain and Ireland                                                                       |
| ASPEN      | American Society for Parenteral and Enteral Nutrition                                                                      |
| BAPEN      | British Association for Parenteral and Enteral Nutrition                                                                   |
| BDA        | British Dietetic Association                                                                                               |
| BMI        | body mass index                                                                                                            |
| CHERRIES   | Checklist for Reporting Results of Internet E-Surveys                                                                      |
| C-MUST     | Hong Kong Chinese Malnutrition Universal Screening Tool                                                                    |
| CNST       | Canadian Nutrition Screening Tool                                                                                          |
| CONSORT    | Consolidated Standards of Reporting Trials                                                                                 |
| COREQ-32   | Consolidated criteria for reporting qualitative research                                                                   |
| COVID-19   | Coronavirus disease-2019                                                                                                   |
| CT         | computerised tomography                                                                                                    |
| DBTH NHSFT | Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust                                                            |
| DCE        | discrete Choice Experiment                                                                                                 |
| EGS        | emergency general surgery                                                                                                  |
| EL         | emergency laparotomy                                                                                                       |
| EN         | enteral nutrition                                                                                                          |
| ERAS       | Enhanced Recovery After Surgery                                                                                            |
| ESPEN      | The European Society for Clinical Nutrition and Metabolism (formerly European Society of Enteral and Parenteral Nutrition) |
| FELANPE    | Federacion Latino Americana de Terapia Nutricional Parenteral Y Enteral                                                    |
| FFMI       | fat free mass index                                                                                                        |
| G8         | Geriatric 8                                                                                                                |
| GI         | gastrointestinal                                                                                                           |
| GLIM       | Global Leadership Initiative on Malnutrition                                                                               |
| GNRI       | Geriatric Nutrition Risk Index                                                                                             |
| HGS        | handgrip strength                                                                                                          |
| HRA        | Health Research Authority                                                                                                  |
| ICD-10     | International Classification of Disease, tenth revision                                                                    |
| ICU        | intensive care unit                                                                                                        |
| IF         | intestinal failure                                                                                                         |
| MAG        | Malnutrition Advisory Group                                                                                                |
| mGLIM      | modified Global Leadership Initiative on Malnutrition                                                                      |
| mGPS       | modified Glasgow prognostic score                                                                                          |
| MNA        | Mini Nutritional Assessment                                                                                                |
| MNA-SF     | Mini Nutritional Assessment-Short Form                                                                                     |
| mNUTRIC    | modified NUTRIC                                                                                                            |
| MST        | Malnutrition Screening Tool                                                                                                |
| MUAC       | mean upper arm circumference                                                                                               |
| MUST       | Malnutrition Universal Screening Tool                                                                                      |



|          |                                                                                           |
|----------|-------------------------------------------------------------------------------------------|
| N/A      | not applicable                                                                            |
| NASBO    | National Audit of Small Bowel Obstruction                                                 |
| NBM      | nil by mouth                                                                              |
| NCEPOD   | National Confidential Enquiry into Patient Outcome and Death                              |
| NELA     | National Emergency Laparotomy Audit                                                       |
| NHS      | National Health Service                                                                   |
| NICE     | National Institute for Health and Care Excellence                                         |
| NRI      | Nutrition Risk Index                                                                      |
| NRS      | Nutrition Risk Score                                                                      |
| NRS 2002 | Nutrition Risk Screening 2002                                                             |
| NS       | not stated                                                                                |
| NSEq     | Nutrition Screening Equation                                                              |
| NST      | Nutrition Support Team                                                                    |
| NUTRIC   | Nutrition Risk in Critically ill                                                          |
| OR       | odds ratio                                                                                |
| PENSA    | Parenteral and Enteral Nutrition Society of Asia                                          |
| PG-SGA   | Patient Generated Subjective Global Assessment                                            |
| PIS      | participant information sheet                                                             |
| PN       | Parenteral nutrition                                                                      |
| PNI      | Prognostic Nutrition Index                                                                |
| POSSUM   | Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity |
| PRISMA   | Preferred Reporting Items for Systematic Reviews and Meta-Analyses                        |
| RCT      | randomised controlled trial                                                               |
| REC      | Research Ethics Committee                                                                 |
| REDCap   | Research Electronic Data capture                                                          |
| SGA      | Subjective Global Assessment                                                              |
| SIRS     | Systemic Inflammatory Response Syndrome                                                   |
| SNAQ     | Short Nutritional Assessment Questionnaire                                                |
| SOFA     | Sequential Organ Failure Assessment                                                       |
| TLC      | total leucocyte count                                                                     |
| TNL      | total number of lymphocytes                                                               |
| URS      | Undernutrition Risk Score                                                                 |
| USA      | United States of America                                                                  |
| WHO      | World Health Organisation                                                                 |

## VI Abstract

### Background and aims

Emergency general surgery (EGS) practice is high risk. As many as 40-60% of EGS patients are malnourished. The resultant post-operative catabolic stress means there is a frequent need for nutritional support. Identifying these patients is paramount to minimising this risk but specific guidelines for EGS are lacking. The failure to do so leads to an increased risk of patient and organisational costs. This thesis aimed to examine the similarities/ differences in how surgeons identify malnourished EGS patients in the UK, and understand why any differences exist.

### Methods and results

A mixed methods approach was used consisting of five studies to explore this issue. Each of these components is summarised below:

- A systematic review of 31 studies described inconsistency in how malnutrition is defined in EGS research literature. Many nutritional screening tools, assessment tools and alternative makers of nutritional status are used. Body mass index and albumin are the main indicators.
- A national survey of 166 National Emergency Laparotomy Audit (NELA) Leads representing 117/167 (70.1%) of hospitals in England and Wales Leads described inconsistency in current practice in identifying malnutrition in NELA-eligible patients. Several clinical and organisational barriers exist. There was no correlation with hospital laparotomy volume.
- Semi-structured qualitative interviews with 18 consultants practising EGS revealed many barriers affect the approach surgeons use to determine malnutrition in EGS patients. This can impact clinical and operative decision making, which was influenced by hospital setting.
- A national survey of 148 general surgeons highlighted that irrespective of seniority and IF experience, surgeons recognise malnutrition is important and can affect patient outcomes. However, there was a lack of confidence in doing so and nutritional training was limited.
- A discrete choice experiment of 148 surgeons demonstrated six variables were independently associated with the decision to start nutritional support in EGS, but surgeon and IF experience were not. Days likely to be without oral intake influenced decision making most.

### Conclusions

There is inconsistency in how surgeons identify malnourished EGS patients in research and clinical practice. This is influenced by institutional factors, and impacts decision making on timing of nutritional support and operative outcomes. Twenty-one key findings are highlighted.

# 1 Introduction

## 1.1 Emergency general surgery

Emergency general surgery (EGS) is a surgical subspecialty that cares for patients admitted as an emergency to hospital with any condition that affects the gastrointestinal tract from the oesophagus to the anus(1). The scope of diagnoses are varied, however a vast number of patients are admitted as their bowel is not working as it should be. This may be because it is blocked (obstructed) due to a variety of causes, there is not an adequate blood supply (ischaemic), there is a twist (internal hernia or volvulus) or it has a hole in it (perforated); essentially it has 'failed'.

EGS comprises approximately half of the workload of the general surgeon(2). In England in 2018/19, there were 714,528 emergency general surgical admissions(3). EGS was the single largest group of surgical patients admitted to hospital(3). More than a quarter of EGS patients require surgery(4,5). Depending on the exact nature of the problem, clinical situation and patient co-morbidities, some patients are managed surgically (with an operation) whilst a number of others are managed conservatively (with no operation).

EGS is inherently higher risk than elective surgery(6,7). It is estimated that EGS patients have a 2.5-6 times greater risk of a significant complication or mortality, respectively, in comparison to elective patients(8). Thompson and Stonebridge (2005) put mortality as high as eight times that of elective surgery(6). Within the cohort of EGS admissions, there are identified higher risk groups(7,9–11). For example, although appendicitis is the most common EGS condition worldwide, with which some patients can be extremely unwell, it has a low 30-day mortality of approximately 0.02-0.5%(10,12). Comparatively, patients undergoing an emergency laparotomy (EL) have a higher 30-day mortality. Although an international study has estimated 24-hour mortality to be 4.8% and 30-day mortality to be 14.9% for EL(12), recent UK data from the National Emergency Laparotomy Audit (NELA) reports describe annual improvements and currently 30-day mortality after EL is 8.7% in 2019-2020(13). Yet mortality after admission to the intensive care unit (ICU) following EGS has been reported to be as high as 28.6%(10).

### **Emergency laparotomy**

Multiple definitions of 'emergency laparotomy' exist(14). A 'laparotomy' is a surgical incision into the abdominal cavity, often in the midline. 'Emergency' is used by the National Confidential Enquiry into

Patient Outcome and Death (NCEPOD) and is defined as 'expedited, urgent or emergency' surgery(15). Others include 'non-elective surgery'.

An emergency laparotomy (EL) is a term often interchangeable with exploratory laparotomy, and provides quick access to confirm a diagnosis and proceed to treating the patient. There are approximately 22,000 ELs recorded on the NELA database in England and Wales each year, equating to almost 3% of all EGS admissions(16). There are a variety of reasons why an EL may be performed opposed to minimally invasive surgery or no surgery at all(17). It may follow urgent imaging such as a computerised tomography (CT) scan, or the patient may proceed straight to EL if they are so unwell on initial assessment, or have sustained trauma. It is worth noting that emergency laparoscopy (emergency keyhole operation to examine the abdomen) has a growing, but still limited, role in diagnosing and treating EGS patients(18).

### **Risk factors and stratifying the high risk EGS patient**

There are a number of risk factors that can increase the likelihood of complications and mortality post-treatment. These can be categorised as: patient risk factors (such as age, co-morbidity and frailty, resulting in 'poor physiological reserve'); surgical risk factors (such as diagnosis, experience and subspecialty of surgeon performing the operation and destination of post-operative care); as well as, organisational risk factors (such as number of ICU beds and access to diagnostic imaging services out of hours)(9). Over half of all EL in England and Wales are in patients aged 65 years and over(13). Evidently, there is much room to improve outcomes in this patient population(9,10) and identifying this high risk population is important to target support.

Patients may be considered 'high risk' based on clinical judgement alone. However, several tools can assist in stratifying patients according to their risk of various outcome measures, typically morbidity and mortality. These may take a global view such as the American Society of Anesthesiologists (ASA) grade, the Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (POSSUM) or the Acute Physiology and Chronic Health Evaluation II (APACHE II) score(19,20). Patient comorbidities are linked to surgical outcomes, and 38% of patients having an EL in England and Wales are ASA 3(16). This means they have a severe systemic disease but it is not life-threatening(13), and are at greater risk of morbidity and mortality than someone who does not have any health problems (ASA 1).

Risk scores may also focus on a specific diagnosis. There are at least 26 scoring systems for identifying and managing patients with appendicitis alone(21), despite patients being at low-risk of major adverse outcome. There have been specific high risk diagnoses (as defined by the International Classification of Disease, tenth revision (ICD-10) diagnostic codes) identified within the EGS cohort(9,22), but with over 400 ICD-10 surgical procedures that can be coded for by an EL(23), many risk scores focus on particular patient groups. 'NELA-eligible' patients are those that meet the inclusion criteria to be entered in to the NELA database(24). They are stratified using the NELA risk score(25). Originally it provided an estimate of risk for morbidity and mortality in the next 30 days following emergency abdominal surgery (EL and emergency laparoscopy), and was based on data entered into the database between 2014-2016. It has since been updated and focusses on mortality at 30 days, and uses data entered into the database between 2016-2019. Its estimate combines the ASA score, patient haemodynamics, haematological and biochemical results, history of cardiorespiratory disease, and operative details such as severity of anticipated malignancy, urgency, peritoneal soiling and indication for surgery(25,26). An EL is inherently high risk surgery, but can be more so for select patient groups. Patients with a predicted mortality of  $\geq 5\%$  based on either the NELA or POSSUM score are considered high risk(16,19) and it is recommended that post-operative care continues in ICU. Papers 2 and 3 will specifically refer to 'NELA-eligible' patients when exploring how clinicians identify high risk EGS patients.

## **The stress response to surgery**

The stress response to surgery, or surgical stress, has long been described by two phases. First, the 'ebb' phase typically describes a hypoactive metabolic response seen from the point of injury lasting for several hours, after which a second hyperactive metabolic 'flow' phase starts a few days later and may be much more prolonged(27). A third 'recovery' phase has also been described(28). However, it is much more complex than this(29–31). Surgical stress describes the physiological changes at a micro and macro cellular level due to a surgical insult or procedure, and are akin to a systemic inflammatory response syndrome (SIRS) evident in other injuries that stress the human body(28,29,32). These include activation of multiple neuroendocrine hormonal pathways that increase the release of catecholamines, aldosterone, cortisol, growth hormone, glucagon and anti-diuretic hormone, with reduced insulin secretion and sensitivity(28,29,33). Additionally, a range of anti-inflammatory and pro-inflammatory immune pathways are upregulated also as part of an immunological response(28,33). These cause hypermetabolism and a catabolic state. There is increased proteolysis, lipolysis, glycogenolysis and gluconeogenesis with consequent loss of fat and lean muscle stores and a hyperglycaemic state.

Understanding the stress response to surgery is important because the catabolic state induced by surgical stress is a consumptive process. Optimising patient outcomes (reduce complications and mortality) could involve either targeting neuroendocrine pathways that attenuate the stress response, or ensuring patients are provided with sufficient nutritional support until they recover with time (**Figure 1.1**) (28,33). The latter will be discussed as part of the evidence summary for nutritional support in EGS.

The magnitude of the stress response is relative to the degree and duration of surgical insult(28). Laparoscopic and robotic surgery demonstrate reduced stress responses(34,35), as can anaesthetic technique, analgesia and various other pathway modulating methods(28,33). Clinical outcomes are directly affected by the surgical stress response and exacerbated by patient factors such as poor physiological reserve (capacity to recover from insult)(36). Central to this is the relative insulin resistance, which has been described as the hallmark of the surgical stress response, and is the main pathogenic factor for outcome after surgery(37). EGS patients suffer acute illness, the presence of uncontrolled comorbidities, prolonged fasting, but also pain and prolonged bed rest, all of which will heighten the stress response and worsen clinical outcomes(28).

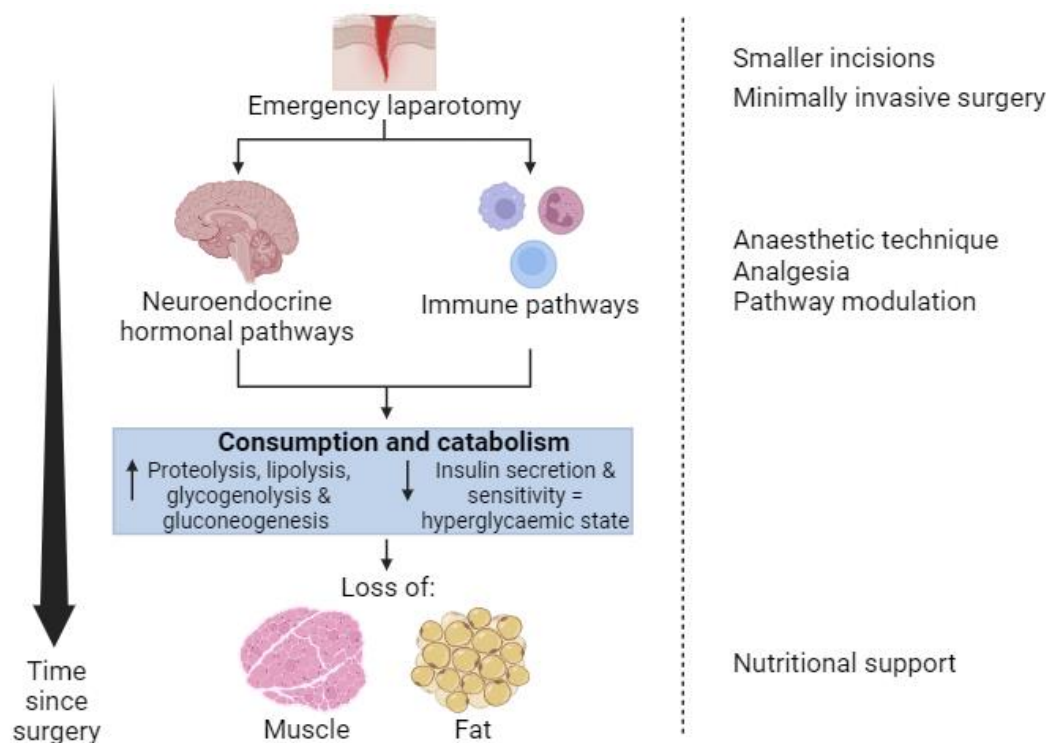


**Figure 1.1:** Stress response and nutritional impact

Methods of reducing stress response shown on right. Created in BioRender.com(38). Adapted from (28).

## Intestinal Failure

In addition to the catabolic stress response leading to nutritional compromise, patients who have had an EL are at risk of developing intestinal failure (IF). This may be as a direct result of their gastrointestinal diagnosis, as part of their recovery phase, or as a complication of surgery. Recognising and managing it early is important to prevent further nutritional deficit. The European Society for Clinical Nutrition and Metabolism define IF as “the reduction of gut function below the minimum necessary for the absorption of macronutrients and/or water and electrolytes, such that intravenous supplementation is required to maintain health and/or growth”(39). The three types of IF have been summarised (**Table 1.1**). Type 1 IF is managed in local hospitals, while patients with type 3 IF are managed in specialist intestinal failure units. Patients with type 2 IF may be referred to these units if they meet referral guidelines, such that they appear to be progressing to type 3 IF(40).

| Feature                    | Type 1                                                   | Type 2                                                                                                                     | Type 3                                                                                                |
|----------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| <b>Duration</b>            | ‘Acute’<br>←<28 days                                     | 28 days-6 months<br>↔                                                                                                      | ‘Chronic’<br>≥6 months                                                                                |
| <b>Typical aetiology</b>   | Post-operative ileus;<br>acute intestinal<br>obstruction | Sepsis; bowel resection<br>secondary to Crohn’s<br>disease or ischaemia;<br>surgical complications;<br>intestinal fistulae | As per type 2 IF; short<br>bowel syndrome;<br>chronic intestinal<br>obstruction; motility<br>disorder |
| <b>Incidence(41)</b>       | 10-30%                                                   | 9 patients/ million                                                                                                        | Rare                                                                                                  |
| <b>Reversible(39)</b>      | Yes                                                      | Maybe                                                                                                                      | Often not                                                                                             |
| <b>Nutritional support</b> | May require short-term<br>parenteral nutrition           | May require long-term<br>parenteral nutrition                                                                              | Home parenteral<br>nutrition                                                                          |

**Table 1.1:** Types of intestinal failure

## 1.2 Nutrition in emergency general surgery

While intestinal failure is one such cause of malnutrition in EGS patients, there are many other causes too (**Figure 1.2**). A patient's pre-existing condition and nutritional status is an important starting block, and contributes to their physiological reserve. Inadequate intake, excessive loss, malabsorption and increased metabolic demand through the stress response contribute to reducing the likelihood of a patient meeting nutritional demands and suffering poorer clinical outcomes (morbidity and mortality).

An abundance of research regarding perioperative nutritional support in elective surgical patients exists in comparison to EGS patients, typically in the context of early recovery after surgery (ERAS) protocols(42). A recent systematic review has indicated that ERAS protocols are being tested in the EGS cohort, although the data is limited and more research is needed as to their effectiveness(43). However, many differences between elective and EGS patients remain. It is recommended elective patients are offered nutritional support which typically starts pre-operatively(44). Elective surgery enables optimisation of comorbidities, or other factors such as anaemia with iron transfusions(45). These pre-operative windows of opportunity are not present in emergency surgery. Furthermore, EGS patients are often kept nil by mouth (NBM; when no oral intake permitted) as part of the treatment plan for intestinal failure, whilst awaiting surgery or whilst recovering post-operatively; and this is often for far longer than for elective patients(46). ERAS and current clinical guidelines actively discourage this in the elective setting(44). In addition to this and from personal experience, EGS patients may present to hospital obtunded, having had large fluid shifts exacerbated through fever, vomiting, diarrhoea, or other losses. This can cause a synchronous acute kidney injury or other medical emergency which requires resuscitation prior to surgical intervention.

Although these issues are often considered pre-operatively and may result in a purposeful, delayed surgical intervention on the balance of risk, often the situation mandates that this is not possible. The subsequent metabolic stress response will only exacerbate the patient's situation and worsen outcomes(47). Indeed, within the EGS population, it has been established that malnutrition is an independent risk factor for worse patient outcomes including mortality(48).



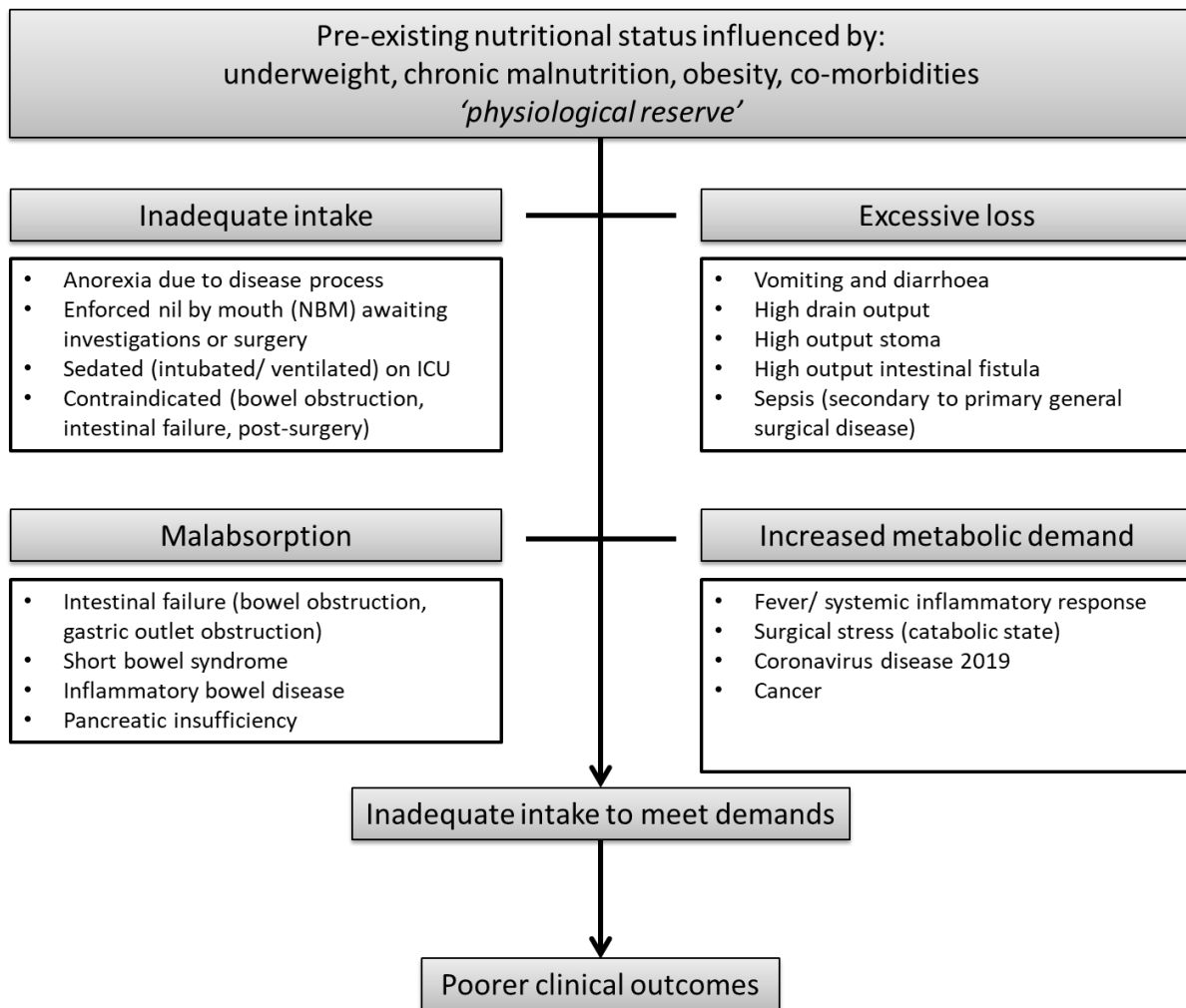


**Figure 1.2:** Causes of malnutrition in emergency surgical patients

Pre-existing nutritional status will influence physiological reserve, acting as a 'starting point' prior to any surgery. Some or all of these causes of malnutrition in EGS patients may occur pre-, intra- and post-operatively to adversely affect outcomes.

Although estimates of hospital admissions suggest a fifth of patients are nutritionally at risk, the incidence of malnutrition in EGS patients is not known(49). In a UK national cohort study including over 2,000 patients assessing the burden of EGS patients diagnosed with small bowel obstruction, half underwent operative management. Indeed, 35.7% of patients were moderate risk and 5.7% were at severe risk of malnutrition as classified by the Nutrition Risk Index (NRI)(50). In the same cohort, only approximately 40% of patients identified as moderate nutrition risk and 62% of patients identified as severe nutrition risk received a nutritional intervention, despite a 2.4 times and a 4.2 times greater risk of in-hospital mortality, respectively(51). Malnutrition was identified as an independent risk factor for mortality(51). These results are similar to a study including approximately 1400 EGS patients admitted to ICU, whereby following a dietitian's assessment, 60% of patients had nonspecific

malnutrition and 8% had protein-energy malnutrition(8). These patients had a 1.5-3 times increased mortality at 90 days compared to non-malnourished patients, respectively. Again, malnutrition was identified as an independent risk factor for mortality. However, malnutrition can also lead to more post-operative complications including nosocomial infections(51), and increased length of stay(7) and healthcare costs(7). While increasing nutritional awareness may be resource intensive and will lead to increased costs, in 1995 the King's Fund Report estimated cost savings of £266 million/ year if in-patient undernutrition were to be addressed. This is likely to underestimate the savings in today's economic climate(52). The British Association for Parenteral and Enteral Nutrition (BAPEN) report the cost of malnutrition as 15% of total expenditure on health and social care, at £19.6bn in England in 2011-2012(53). Older adults account for over half of this.

## **Nutrition screening and assessment**

Despite being used interchangeably in clinical practice and research, nutrition screening and assessment are very different. Identifying malnutrition in patients can be considered a two-step process (**Figure 1.3**). First, patients are identified as being at risk of malnutrition through screening. This can be performed by any healthcare professional. Then, there is an assessment of nutritional status, typically by undertaken by a dietitian, which aims to characterise whether the patient is indeed malnourished, and to what degree. Depending on this, an appropriate nutritional intervention can be recommended. This is reiterated by the British Dietetic Association (BDA) Model and Process of Nutrition and Dietetic Practice(54). This places the identification (screening) of nutritional need outside the Model and Process, which starts with a formal assessment of nutrition status. The American Academy of Nutrition and Dietetics definition of screening also recognises the same, that nutrition screening is the process of identifying patients who *may* have a nutrition diagnosis and benefit from an assessment and intervention by a registered dietitian nutritionist(55). The Academy recommends using the Malnutrition Screening Tool (MST) for all populations and settings. This tool will be discussed in due course.

Nutrition screening can be considered to follow similar principles to those outlined by Wilson and Jungner in 1968(56). In summary, any nutrition screening tool should be a simple, quick, economical and follow a standardised process. It should be possible that any healthcare member can perform the screening. If possible, they should be validated in the desired population for which they are to be used, although many tools have been purposefully designed to be used in all populations at the point of admission to hospital. Ideally the screening tool will have a high sensitivity such that it correctly identifies all patients who are malnourished. A high specificity would also mean it correctly identifies

patients who are not malnourished; but often it is a balance. It has been suggested that they should be predictors of success of nutritional therapy(48), however this is beyond the scope of what a screening tool should be. Some tools have been subsequently validated to be predictors of clinical outcomes such as length of stay or post-operative complications, but again, these are usually beyond the original aim of the screening tool and ought not be used as such.

Nutrition assessment is much more comprehensive. It involves the systematic process of evaluating nutritional status in order to inform decisions regarding the nature and cause of malnutrition. The BDA advises this process involves gathering relevant data from the following areas: anthropometry, biochemistry, clinical/physical, dietary, environmental/behavioural/social and functional(54). However, some tools exist as 'nutrition assessment tools' in that a more global assessment is performed. Depending on the overall score, there is typically a recommendation for nutrition intervention or evaluation by a dietitian.

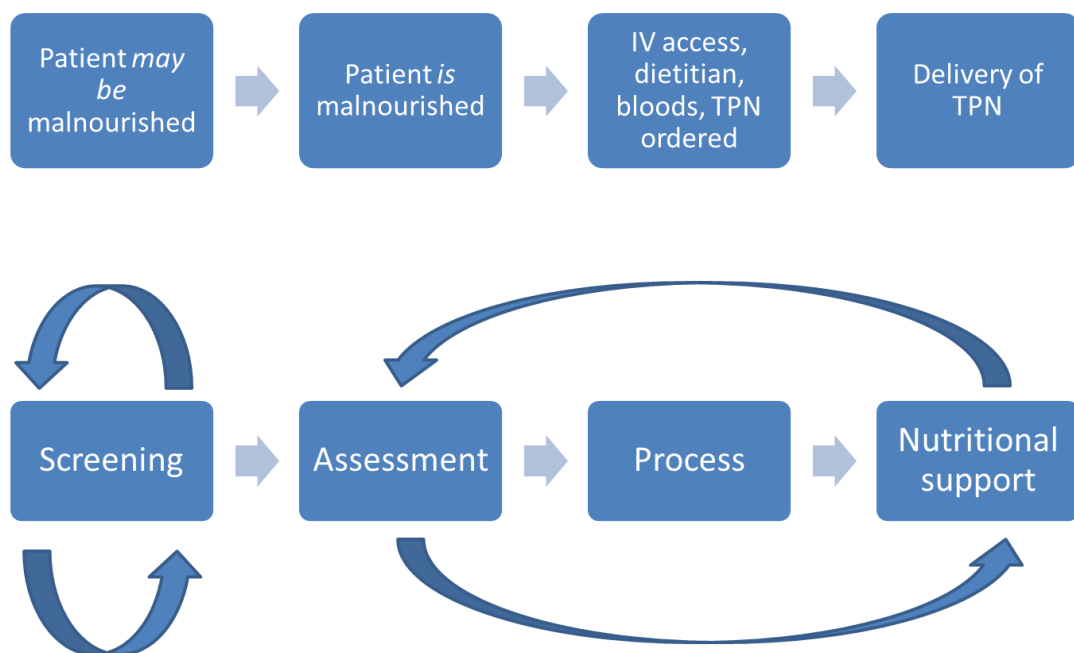


**Figure 1.3:** Process of initiating nutritional support

An extensive study identified 71 screening and assessment tools(57). Of the 35 tools reviewed, only one of them was specifically intended for the identification of malnutrition in a surgical population, the Undernutrition Risk Score(58).

A number of issues paramount to the design, validation and implementation of a variety of screening and assessment tools that currently exist are discussed at length in a systematic review of nutrition screening tools(59). There are issues surrounding the complexity of some tools. Some consist of three yes or no questions only whilst others are more extensive questionnaires which take a long time to complete. More complex tools combine a number of factors such as history, a clinical examination, and biochemical results, resulting in the calculation of a 'score'. Occasionally the boundary between a screening and assessment tool blurs. However, the lack of a gold standard is an issue that has an impact on research in this area and the clinical use of the tool in question. In order to show effectiveness of a new tool, they are often validated against existing tools(59). Yet the population that the new tool is being evaluated in may be completely different to that which the reference tool was validated in. This is in the context in which it could be considered a moot point to screen for malnutrition among patients undergoing a laparotomy; many are high risk of such in any case that starting nutritional support arguably should be initiated from the outset. However, given the volume of laparotomies in England and Wales alone, this would have huge resource implications. Further, tools which were initially designed for identifying malnutrition in a patient population have been subsequently assessed to whether they identify worse clinical outcomes, which is beyond their initial intention and capacity.

There have been a number of contemporary systematic reviews examining malnutrition for specific patient groups including heart failure(60), cancer patients(61), cirrhosis(62), inflammatory bowel disease(63), cachexia and sarcopenia(64) and coronavirus disease 2019 (COVID-19)(65), but none has been identified for EGS.

The following section explores commonly used screening and assessment tools in EGS research, reviewing the original development study for the tool and with a particular focus on the surgical patients included in the study and the 'gold standard' used when assessing its validity.

## **Nutrition screening tools**

Many screening tools were developed to identify malnutrition in all patient groups, including surgical patients. Some tools focus on specific patient groups. Some tools have since been used as the standard upon which subsequent screening tools are validated. As discussed later, several organisations recommend the use of select tools, including the Malnutrition Universal Screening Tool (MUST), the Nutritional Risk Screening 2002 (NRS 2002), the Mini Nutritional Assessment-Short Form (MNA-SF) or the Nutrition Risk in Critically ill (NUTRIC) tools. Nine tools used for screening patients will be discussed

in the context of identifying malnutrition in EGS, with particular focus on those tools recommended by international organisations. A summary of these tools is provided in **Table 1.2**, presented according to year of publication.

### **Nutrition Screening Tool**

The Nutrition Screening Tool was one of the earliest screening tools described, in the same study as the Nutrition Screening Equation (NSEq)(66). In the Nutrition Screening Tool, seven parameters are scored. The population included a mix of medical and surgical adult inpatients; however it is not known what the proportions of each were. In a relatively archaic system, the screening was completed by an untrained person such as the patient, a family member or a hospital volunteer, and then the form delivered to a dietitian to calculate the scores. Scoring  $\geq 6$  points resulted in a patient being deemed at risk of malnutrition and a referral to a dietitian was recommended(66). Six points are scored for a serum albumin  $\leq 3.5$ mmol alone. The tool was compared to results from a full nutrition assessment, and was found to have a sensitivity of 0.40 and specificity of 0.95. The sensitivity is extremely low and as discussed earlier, a screening tool ought to be highly sensitive. However, the study albumin was not available for a complete Nutrition Screening Tool score in many cases initially, and when these were re-scored, the Nutrition Screening Tool had a sensitivity of 0.82 and specificity of 0.65. Consequently, albumin was considered a major determinant in risk of malnutrition. The use of albumin as a marker of malnutrition is now not recommended and discussed later.

### **Nutrition Screening Equation**

In order to circumnavigate some of the pitfalls of the Nutrition Screening Tool, including the reliance of data gathering by family members that may misconstrue the questions, the Nutrition Screening Equation (NSEq) was derived following discriminant analysis of the Nutrition Screening Tool(66). The NSEq had far superior sensitivity (0.86) and specificity (0.96) results than the NST in the original population, and so it was subsequently tested in a new population. A total of 151 random medical and surgical patients were assessed using the NSEq against a full nutrition screening and the NST(66). The NSEq had a sensitivity of 0.92 and a specificity of 0.85. This is better than the full nutrition assessment (sensitivity = 0.72, specificity = 0.84). It is worth noting that the methodology was markedly different. First, trained staff implemented the NSEq. Second, it was a different hospital altogether. This makes direct comparisons between the screening methods difficult, and raises the question regarding the validity of the results. The Nutrition Screening Tool nor the NSEq have not been described or validated in surgical patients since.

## **Nutrition Risk Score**

The Nutrition Risk Score (NRS) tool is again, a multipurpose screening tool but was designed for adults and paediatrics of all specialties, specifically targeted to identify undernutrition(67). It was developed in response to the highlighted clinical and financial benefits of identifying and treating malnutrition in hospital patients in the Kings Fund Report(52). This report also recommended a patient's nutritional status be documented in medical and nursing admission records. There are five fields scoring up to three points each with a maximum of 15 points in total. No cut off for recommendations are given although it does appear that depending on the scores, there are low, medium and high risk categories. The fields include weight loss, BMI, appetite, ability to eat, and a 'stress factor'. The NRS was tested in 153 patients, of which 18.5% (n = 28) were surgical. It is not clear what subspecialty, what diagnosis or what surgical journey the patient had. The authors comment that the tool overestimates risk as no moderate or severe at risk patients were missed when compared to a risk assessment performed by dietitians. However, if a surgical patient is admitted with a no recent weight loss and a normal BMI, but is severely vomiting, kept NBM and subsequently has major surgery, they will score only 8 points. This seems exceedingly low and may not identify this patient as at high risk of malnutrition. The second issue is that a patient with a BMI equal to or greater than 20Kg/m<sup>2</sup> scores 0 points. In today's population, this may again underestimate the actual risk posed given the rising obesity(68) and the known presence of micronutrient deficiencies in obesity(69,70).

## **Malnutrition Screening Tool**

The Malnutrition Screening Tool (MST) was developed to be as simple as possible. Anthropometric data, biochemical data or calculations such as BMI or percentage weight loss were dismissed as these take time to process(71). Consequently, screening questions were developed from the literature and clinical experience. Twenty questions, individually and as various combinations, were validated against the Subjective Global Assessment (SGA). Those questions or combinations of questions having the highest sensitivity and specificity ( $\geq 90\%$  cut off) for predicting nutritional risk were selected. Two questions were selected, which were 'have you been eating poorly because of a decreased appetite?' and "have you lost weight recently without trying?"(71). There was good correlation with the SGA (93% sensitivity and specificity, positive predictive value 98.4% and negative predictive value 72.7%)(71). The tool was further validated against anthropometric data, biochemical data, grip strength and length of stay, as well as reliability testing with independent dietitians or nursing assistants, with good results. However, of the 408 patients the MST was validated in, only 13.2% (n = 54) were general surgery or urology patients. Implementation of the MST has been shown to be feasible in a medical patient cohort(72). Further, as previously mentioned, following an extensive

literature review the MST is recommended by the Academy of Nutrition and Dietetics to screen adults for malnutrition regardless of age, medical history or setting(55). The evidence base for this recommendation is far-reaching, however there was only one study of 151 patients which included surgical patients(73). Unfortunately the full text for this study is not available, but on review of the tables it appears there were very few surgical patients. As such, recommending MST in EGS based on this evidence is weak and needs testing specifically. Finally, the MST has been shown to predict postoperative complications in a mixed surgical population, although it was the worst tool of those tested(74). However this is probably beyond the scope for which the tool was initially developed for.

### **Undernutrition Risk Score**

In similar fashion to the previous screening tools, the Undernutrition Risk Score (URS) assigns scores to seven criteria related to weight, degree of weight loss, appetite, gut function and 'medical condition'(58). The higher the score, the greater the risk of undernutrition; a score of equal to or greater than 9/21 identifies a patient as at high risk, and recommendations are offered. The URS was evaluated in a small sample of 40 surgical patients against a detailed nutritional assessment scores performed by dietitians (anthropometrics, biochemical, handgrip) and the NRI; the latter determined nutritional status and is discussed in due course. The authors note that the NRI is not a gold standard and caution when interpreting the results. Overall, the URS identified 71.4% (10/ 14) patients were scored as moderate or severe risk according to the NRI(58). Although this screening tool was specifically designed to identify malnutrition in surgical patients, in contrast to the previously discussed tools, it is not clear whether these patients were elective or EGS, or indeed which surgical specialty they were admitted under. Importantly though, these patients were able to eat so probably do not reflect the high risk EGS patients that have intestinal failure and need nutritional support.

### **Malnutrition Universal Screening Tool**

The Malnutrition Universal Screening Tool (MUST) was developed from a community tool by the Malnutrition Advisory Group (MAG), a committee of the British Association for Parenteral and Enteral Nutrition (BAPEN), having performed an evidence review(75). It is widely used in the UK. Its intention was for it to be appropriate for all adult inpatients, outpatients and care homes. Three categories including BMI, unintentional weight loss and 'acute disease effect' together contribute to a total score out of six. Acute disease effect considers if the patient is acutely unwell and there is or likely to be no nutritional intake for more than five days. A score of two or more identify the patient as high risk of malnutrition and a referral to a dietitian or Nutrition Support Team is recommended. MUST is reliable

and has been well validated in many settings in terms face validity, content validity, concurrent validity and predictive validity(75).

Since this development paper, MUST has been examined and compared with other validated nutritional tools in surgical patients. A study evaluating 302 surgical patients aged  $\geq 65$  years scheduled for surgery compared MUST and the Mini-Nutritional Assessment Short-Form (MNA-SF)(76). The MNA-SF is validated in the elderly population(77,78), although not specifically in surgical patients. MUST was found to have a moderate agreement to MNA-SF(76). Although rate of overall complications and length of stay was significantly associated with patients at a high risk of malnutrition according to MUST, approximately a quarter of these patients were hernias and a quarter cholecystectomies. These are generally low risk procedures in comparison to when performed in EGS patients. Another study compared MUST, along with BMI, weight loss  $\geq 5\%$  in six months, the Nutrition Risk Screening (NRS) 2002 and the Nutrition Risk Index (NRI) using the SGA as the standard(79). This study was relatively large with 300 surgical patients, of which 75% ( $n = 229$ ) were general surgery and 46% ( $n = 137$ ) were 'non-elective'. MUST effectively identified patients at risk of malnutrition when compared to SGA; only NRI was slightly better. Finally, a large study of 501 older (aged  $\geq 65$  years) general surgical patients identified 14.6% patients at high risk of malnutrition(80). There were only 17% emergency operations with no details regarding which exactly these were. Experience would suggest many EGS patients would be considered high risk based on the 'acute disease effect' alone, consequently affecting its discriminatory value, but this study may suggest otherwise. MUST was significantly associated with postoperative death ( $OR = 9.1$ ,  $p = 0.047$  for  $MUST = 1$ ;  $OR = 11.9$ ,  $p = 0.035$  for  $MUST \text{ score} \geq 2$ ) and postoperative hospital stay. However likewise with MST, this is probably beyond the scope for which the tool was initially developed. Interestingly, emergency surgery itself was not associated with postoperative complication despite EGS being known to be high risk, and more so than elective surgery(6–8).

### **Nutritional Risk Screening 2002**

The Nutrition Risk Screening 2002 (NRS 2002) tool was developed to identify patients most likely to benefit from nutritional support and this process was markedly different from previous nutritional tool development studies(81). The tool was developed by the Danish Society for Parenteral and Enteral Nutrition whilst describing a system for screening nutritional risk. It was validated against the current literature.



The three parameters incorporated into the tool were based on the assumption that nutritional support will be indicated in undernutrition and/ or an increase in requirement. These are undernutrition (measured by percentage weight loss, change in food intake or BMI), severity of disease and age. A retrospective analysis of 128 existing randomised controlled trials (totalling 8,944 patients), of which 48 were related to gastrointestinal surgery, was performed to assess whether it could determine between trials with a positive outcome and those with a negative outcome(81). A higher score indicated an increased likelihood for nutritional intervention in a step-wise fashion. A score of  $\geq 3$  was identified as an overall cut off, although there were differences between enteral and oral nutritional support, and parenteral nutritional support. Sensitivity and specificity were 75% and 55%, respectively(81). This study is limited in that the clinical outcome was known when scoring the degree of undernutrition or disease severity; studies with a positive outcome could have been scored more positively. In the same study as described earlier which compared MUST, BMI, weight loss  $\geq 5\%$  in 6 months, NRS 2002 and NRI using the SGA as the standard, NRS 2002 identified 66% of patients as at nutritional risk, the same as MUST(79). In addition, the NRS 2002 and MUST had very strong agreement with SGA (kappa = 0.853 and 0.912, respectively)(79), though this has not been seen in other studies of wider populations(59). Interestingly, in a study evaluating the prevalence of nutrition risk according to the NRS 2002 and nutritional support in 810 elective general surgery patients and how this has changed between 2011 and 2017, although the prevalence of undernutrition has decreased (12.8% from 15.5%), nutrition risk has increased (42.6% from 30.4%) as has nutrition support in those at risk (70.7% from 48.9%)(82). This is in contrast to a study of nutrition risk (according to NRI) and support in emergency small bowel obstruction with more than 2,000 patients, which found that only 40.7% and 62.7% of patients identified to be at moderate or severe risk of malnutrition, respectively, were given nutritional support(50). This may be because of the two different cohort populations (elective vs emergency), the different screening tools used or the poor validity (kappa = 0.336) of the NRI when compared to the SGA(79).

The NRS 2002 would benefit from being validated in a prospective RCT in a single and well-defined population, which would corroborate the original development and validation study.

### **Short Nutritional Assessment Questionnaire**

The Short Nutritional Assessment Questionnaire (SNAQ) was developed specifically for the Dutch language as no tool existed, and other tools with BMI or percentage weight loss were time consuming(83). Although the SNAQ has 'assessment' within its title, it is a screening tool. Its aims were to identify and treat patients at risk of malnutrition. From 26 questions drawn from a variety other

tools and health questionnaires and screening tools including the MNA and the SGA, three questions comprise the SNAQ(83). These are very similar to the questions used in the MST and ask the patient about unintentional weight loss and reduced appetite. In addition, the SNAQ asks about use of supplemental drinks or tube feeding. Questions are scored and nutritional intervention recommended if the patient scores  $\geq 2$ . The validation study comprised of a medical-surgical mixed population, with no details provided regarding the surgical cohort. SNAQ had good results regarding sensitivity (79%) and specificity (83%) for patients  $\geq 2$  points and it was reproducible(83). Its use has been limited to the Netherlands(59).

### **Nutrition Risk in Critically Ill**

The Nutrition Risk in the Critically Ill (NUTRIC) score focuses on all patients in the ICU(84). In this development study the terms 'screening' and 'assessment' tool are confusingly interchangeable, but in essence the NUTRIC aims to quantify risks of adverse outcomes (mortality and mechanical ventilation) which may be modified by nutritional support.

NUTRIC is a complex score, and is an amalgamation of other scoring systems commonly used in ICU. The parameters were developed based on a conceptual model that linked variables which affected nutritional status but were also individually validated against outcomes. There was no gold standard validating criteria, however NUTRIC was cross-validated by using a random split half sample method and then evaluating its discriminative ability on the other half(84). Given this study was a secondary analysis of a study originally designed to evaluate a novel diagnostic marker for sepsis, potential candidate parameters and available data were limited. The parameters include age, the APACHE II score, the Sequential Organ Failure Assessment (SOFA) score, number of co-morbidities, number of days from admission to hospital to admission to ICU, and interleukin-6 levels. The maximum score is 10, and no cut off was defined. The risk tool was then validated in a prospective, multicentre study of 597 patients who were typically started on nutritional support within 24 to 48 hours of ICU admission(84). Complete data related to patients with a stay  $\geq 3$  days, nutritional intake and outcome was available for 35% of patients ( $n = 211$ ). It is unclear exactly how many patients were EGS, although 16.6% ( $n = 99$ ) had a gastrointestinal diagnosis. Patients with increasing NUTRIC scores have worse clinical outcomes in terms of higher mortality and longer duration of mechanical ventilation. NUTRIC had a c-statistic (derived from calculating the area under the receiving operating characteristic curve) of 0.783 for 28 day mortality, indicating adequate performance(84).

Given the cost and lack of access to interleukin-6 levels, NUTRIC has since been further validated in ICU patients without this parameter; the modified NUTRIC (mNUTRIC) has a maximum score of nine(85). Although 28-day mortality increases by odds of 1.4 for every point increase, mNUTRIC is worse at predicting 28-day mortality than NUTRIC (c-statistic = 0.648). But nutritional adequacy does reduce mortality(85). A recent systematic review of studies indicates its uptake globally in the ICU setting, but these are mostly observational studies with one intervention study thus far(86).

Finally, a recent study of 206 patients assessed 90 day mortality following abdominal surgery(87). It is not known whether these patients had elective or emergency surgery. These patients received a volume-based feeding protocol. Patients with mNUTRIC scores of  $\geq 5$  had significantly greater postoperative complication rates than patients with mNUTRIC scores  $\leq 5$  (36% vs 20.6%,  $n = 27$ ;  $p = 0.021$ ). The same is also true for 90 day mortality and length of hospital stay(87). Sub-analysis identified that 90 day mortality was significantly greater in high risk (mNUTRIC  $\geq 5$ ) patients with less than 50% energy adequacy (36.4%,  $n = 12$ ) compared to those with more than 50% energy adequacy (9.5%,  $n = 4$ ;  $p = 0.009$ )(87). Further studies addressing the use of NUTRIC in EGS patients admitted to ICU are needed.

**Table 1.2:** Nutrition screening tools

| Nutrition Screening Tool                             | Reason for Tool Development                                                                                                                                  | Nutrition Screening Parameters and Scores                                                                                                                                                                                                                                                                                                     | Original Patient Population                                                            | Surgical Patient Population                                                      | Comments on study                                                                                                                                          | 'Gold standard' used (validating criteria)                                                                                                                                             |
|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Nutrition Screening Tool, 1994(66)</b>            | To identify patients at risk of malnutrition<br>To re-evaluate the accuracy of the screening tool and whether another tool should be developed to replace it | <ul style="list-style-type: none"> <li>Hospital admission (0-1)</li> <li>Nursing home resident (0-1)</li> <li>Age (0-1)</li> <li>Weight/ height data (0-4)</li> <li>Problems before admission (0-8)</li> <li>Comorbidities (0-8)</li> <li>Admission diagnosis (1-6)</li> </ul> <p>≥6 points = at risk and should be referred to dietitian</p> | 100 adult inpatients (excluding maternity, paediatric, psychiatric and rehabilitation) | Not stated                                                                       | 6 points for serum albumin ≤3.5mmol                                                                                                                        | Full nutrition assessment independent of nutrition screening                                                                                                                           |
| <b>Nutrition Screening Equation (NSEq), 1994(66)</b> | To determine whether the NSEq could replace the Nutrition Screening Tool as it is less time-consuming                                                        | $238.664 (\text{Alb, g/L}) + 0.07242 (\text{TLC, mm}^3) - 24.657 (\% \text{weight loss in 6 months}) < 747.2$                                                                                                                                                                                                                                 | 151 randomly selected medical and surgical patients                                    | Not stated                                                                       | Derived via discriminant analysis of parameters in the Nutrition Screening Tool. Performed in a different hospital than original Nutrition Screening Tool. | <ul style="list-style-type: none"> <li>Full nutrition assessment independent of nutrition screening</li> <li>Nutrition Screening Tool</li> </ul>                                       |
| <b>Nutrition Risk Score (NRS), 1995(67)</b>          | To use in a survey to highlight importance of and promote an MDT approach. Validated in a sample, then evaluated as a screening tool for all patients.       | <ul style="list-style-type: none"> <li>Weight (paeds) (0-6)/ weight loss (adults) (0-3)</li> <li>BMI (adults) (0-3)</li> <li>Appetite (0-3)</li> <li>Ability to eat (0-3)</li> <li>Stress factor (0-3)</li> </ul> <p>Max score = 15<br/>No cut off stated</p>                                                                                 | All patient categories and ages, including paediatrics                                 | 28/153 patients (18.5%)<br><br>No details regarding diagnoses or surgical course | Consecutively admitted patients, no data on diagnosis or management                                                                                        | Initially validated in 20 patients. Correlation between same risk categories using the NRI ( $r = 0.68$ , $p < 0.001$ ) or dietitian clinical impression ( $r = 0.83$ , $p < 0.001$ ). |

|                                                                |                                                                                                       |                                                                                                                                                                                                                                            |                                                                                         |                                                                                             |                                                                                                                                     |                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Malnutrition Screening Tool (MST), 1999</b> (71)            | To identify patients at risk of malnutrition at admission using a simple, reliable and validated tool | <ul style="list-style-type: none"> <li>Recent unintentional weight loss (0-4)</li> <li>Recent poor intake (0-1)</li> </ul> <p>≥2/5 = at risk of malnutrition</p>                                                                           | Adult inpatients (excluding maternity, paediatric, psychiatric)                         | 54/ 408 patients (13.2%) general surgery/ urology                                           | Misclassification rate 7.1% (false negatives 1.2%; false positives 5.9%). 93% sensitivity and specificity. PPV 98.4% and NPV 72.7%. | <ul style="list-style-type: none"> <li>SGA for development of MST</li> <li>Anthropometrics (including handgrip) and biochemical data for convergent validity</li> <li>Predictive validity to length of stay using ANOVA</li> <li>Reliability by independent dietitians/ nutrition assistant</li> </ul> |
| <b>Undernutrition Risk Score, 2000</b> (58)                    | To identify surgical patients at risk of malnutrition on admission                                    | Usual weight (0-2)<br>Weight loss (0-3)<br>Appetite (0-3)<br>Age (0-3)<br>Ability to eat (0-3)<br>Gut function (0-4)<br>Medical condition (0-3)<br>Max score = 21<br>≥9 = high risk                                                        | 40 surgical patients                                                                    | As previous. Complete data on 34 patients                                                   | Pilot study testing a locally designed screening tool Surgical specialty and whether elective/ EGS not stated                       | Detailed nutritional assessment scores involving 3-day diet history, anthropometrics, hand grip, as assessed by dietitians; NRI screening tool used to determine malnutrition status, not dietitian's assessment                                                                                       |
| <b>Malnutrition Universal Screening Tool (MUST), 2003</b> (75) | To identify patients at risk of malnutrition                                                          | <ul style="list-style-type: none"> <li>BMI (0-2)</li> <li>Weight loss (0-2)</li> <li>Acute disease effect (0-2)</li> </ul> <p>Total score:<br/>           &gt;2 = high risk<br/>           1 = medium risk<br/>           0 = low risk</p> | All adult inpatients, outpatients and care homes (intensive care and mental healthcare) | Multiple studies within report comparing validity with other screening tools and parameters | Developed from a community tool                                                                                                     | It was developed by a multidisciplinary group after an evidence review, assessing multiple existing screening tools and populations.                                                                                                                                                                   |
| <b>Nutrition Risk Screening (NRS-2002), 2003</b> (81)          | To identify patients likely to benefit from nutritional support                                       | <ul style="list-style-type: none"> <li>Undernutrition (weight loss, food intake, BMI) (0-3)</li> <li>Severity of disease (0-3)</li> <li>Age (≥70) (0-1)</li> </ul>                                                                         | Adult inpatients requiring nutritional support                                          | 48 RCTs of GI surgery                                                                       |                                                                                                                                     | Whether it can identify positive or negative clinical outcomes from 128 existing RCTs of nutritional support                                                                                                                                                                                           |

|                                                                    |                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                    |                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                     |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ≥3 = at nutritional risk, start nutritional support                |                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                    |                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                     |
| <b>Short Nutritional Assessment Questionnaire, 2005 (SNAQ)(83)</b> | To identify and treat patients at risk of malnutrition, as staff do not have time to calculate BMI or % weight loss | <ul style="list-style-type: none"> <li>Unintentional weight loss ≥6Kg in 6 months (3 points)</li> <li>≥3Kg in 1 month (2 points)</li> <li>Decreased appetite (1 point)</li> <li>Supplemental drinks or tube fed (1 point)</li> </ul> <p>1 = no intervention<br/>2 = moderately malnourished; nutritional intervention<br/>3 = severely malnourished; nutritional intervention; dietitian</p> | <p>Development study: 291 adult medical and surgical patients</p> <p>Validation study: 297 adult medical and surgical patients</p> | Not stated                                                       | <p>SNAQ developed using various health questionnaires and the MNA and SGA</p> <p>SNAQ performed by nurses on admission.</p> <p>38% patients who were referred to the dietitian based on the SNAQ score, were not severely malnourished,</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>Malnutrition defined based on an 'objective standard of malnutrition', which were BMI and unintentional weight loss.</p> <p>SNAQ validated internally with a second, mixed medical-surgical study population</p> |
| <b>NUTRition Risk in the Critically ill (NUTRIC), 2011(84)</b>     | To quantify risk of adverse outcomes that may be modified by nutrition therapy in critical care                     | <ul style="list-style-type: none"> <li>Age (0-2)</li> <li>APACHE II (0-3)</li> <li>SOFA (0-2)</li> <li>Number of comorbidities (0-1)</li> <li>Days from hospital to ICU admit (0-1)</li> <li>IL6 (0-1)</li> </ul> <p>Max = 10; no cut-off</p>                                                                                                                                                | All ICU patients, excluding elective surgery, overdoses and ≤24 hour ICU stay                                                      | Unclear exactly, but 99 (16.6%) had a gastrointestinal diagnosis | <p>Multicentre study. Patients typically started EN within 24-48 hours. Secondary analysis study. Original study was to evaluate a novel diagnostic marker for sepsis. Only 35% (n = 211) patients were in ICU ≥3 days and were evaluable for assessment of nutritional intake and its relation to outcome relative to the NUTRIC score.</p> <p>No comparator. Conceptual model derived variables, which were validated individually against outcomes. NUTRIC was then cross-validated by independently using a random split half sample method and then evaluating its discriminative ability on the other half. Association between the NUTRIC score and ventilation duration in 28-day survivors was also assessed.</p> |                                                                                                                                                                                                                     |

Abbreviations: Albumin (Alb); analysis of variance (ANOVA); Acute Physiology and Chronic Health Evaluation II (APACHE II); body mass index (BMI); enteral nutrition (EN); gastrointestinal (GI); intensive Care Unit (ICU); interleukin-6 (IL6); Kilograms (Kg); multidisciplinary team (MDT); Malnutrition Screening Tool (MST); Malnutrition Universal Screening Tool (MUST); negative predictive value (NPV); Nutrition Risk Index (NRI); Nutrition Risk Score (NRS); Nutritional Risk Score 2002 (NRS 2002); not stated (NS); Nutrition Screening Equation (NSEq); Nutrition Risk in Critically ill (NUTRIC); paediatrics (paeds); positive predictive value (PPV); randomised controlled trial (RCT); Short Nutritional Assessment Questionnaire (SNAQ); Sequential Organ Failure Assessment (SOFA); total leucocyte count (TLC); Undernutrition Risk Score (URS)

## **Nutrition assessment tools**

After identifying patients at risk of malnutrition using a screening tool, they are then referred for a full nutritional assessment by a trained professional. However, some tools exist which have been aimed at performing a nutritional 'assessment'. This has added to the confusion within the literature and led to an interchangeable use of 'screening' and 'assessment'. These are very different processes, even chronologically. However, to avoid further confusion, as the two tools discussed (**Table 1.3**) have 'assessment' in their title, they are discussed here, although are not formal assessments as would be defined by current standards. It is particularly important as the SGA has become the gold standard reference for which many subsequent screening tools have been validated against.

### **'Clinical Assessment'**

Although not strictly a tool, this is the first description of using clinical assessment of nutritional status and forms the basis of the SGA. Selection of the 59 elective surgical patients was convenient, and an assessment by two physicians was performed(88). A third assessor was blinded to these assessments and reviewed outcomes on discharge. Although the assessment criteria were not explicitly described, they were based on details from a history and clinical examination. Patients were considered well nourished (A), mildly malnourished (B) or severely malnourished (C)(88). There was good inter-observer reliability and significant correlation when compared to objective measurements including albumin and percentage actual weight/ ideal body weight. There was no correlation to total lymphocyte count. Further, the incidence of infection, use of antibiotics and longer length of stay was greater in patients who were more malnourished(88).

### **Subjective Global Assessment**

The SGA is a formal and detailed characterisation of the 'Clinical Assessment' as described above(89). Again, following a history and clinical examination, patients are assigned category subjectively; there is no scoring system or weighting scheme. Its main drawback is the need for training to use it. The categories patients can be assigned are well nourished (A), moderately malnourished (B) or severely malnourished (C)(89). This tool was further validated in 202 elective general surgical patients. Again, each variable in the SGA correlated with SGA class and there was good inter-observer agreement(89). Indeed, the SGA has been evaluated in many subsequent studies comprised of all types of adult in-patients(59). One study examined 438 elective general surgical patients in Vietnam and showed there was good correlation between SGA class and postoperative infection (wound infection, intra-abdominal abscess, anastomotic leak)(90). However, its use clinically has been limited, most likely due to the training required to implement it, its subjective nature and the time needed to perform(71).

**Table 1.3:** Nutrition assessment tools

| Nutrition Screening Tool                            | Reason for Tool Development                                                                                                                                                    | Nutrition Screening Parameters and Scores                                                                                                                                                                                                                         | Original Patient Population                                           | Surgical Patient Population | Comments on study                                                                                                                                   | 'Gold standard' used (validating criteria)                                                                                                 |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| <b>'Clinical assessment', 1982(88)</b>              | To determine the reproducibility and validity of clinical assessment of nutritional status in relation to outcome (incidence of infection, use of antibiotics, length of stay) | History: weight loss, oedema, anorexia, vomiting, diarrhoea, altered food intake, chronic illness<br>Exam: jaundice, cheilosis, glossitis, loss of subcutaneous fat, muscle wasting, oedema<br>A = normal<br>B = mild malnutrition<br>C = severe malnutrition     | 59 elective surgical patients                                         | As stated                   | Selection based on every 5 <sup>th</sup> patient admitted to the ward<br>Clinical assessment by two physicians<br>Criteria not explicitly described | Correlations with inter-observer reliability, objective measurements and clinical outcomes (infection, use of antibiotics, length of stay) |
| <b>Subjective Global Assessment (SGA), 1987(89)</b> | To describe the updated technique used by Baker (1982), coining it Subjective Global Assessment                                                                                | History: weight change, dietary intake, GI symptoms, function, disease and its relation to nutritional requirements (stress)<br>Exam: loss of subcutaneous fat, muscle wasting, oedema, ascites<br>A = normal<br>B = mild malnutrition<br>C = severe malnutrition | 202 elective surgical patients (major GI) from two teaching hospitals | As stated                   | Clinical assessment by five clinicians (three residents, one research nurse, one practice nurse)<br>Requires training to use tool                   | Examination of the patient characteristics and SGA ratings, as well as the inter-observer correlation                                      |

Abbreviations: Examination (exam); gastrointestinal (GI); Subjective Global Assessment (SGA).



## Markers of nutritional status and albumin

A full review of the broad range of markers that can be used to assess nutritional status is beyond the scope of this thesis and has been extensively explored in recent reviews(47,91,92). However, it is worth briefly discussing albumin given its influence in the surgical domain.

For more than 50 years, albumin has been regarded as a marker of nutritional status(93,94). Hypoalbuminaemia is commonly seen in malnutrition, and if persistent beyond one week it has been suggested it can be used as an objective marker for malnutrition(95). However, it is recognised to be a negative acute phase marker rather than reflecting impaired protein synthesis associated with malnutrition. Its levels will decrease after acute inflammatory processes such as surgery. Given the long half-life of approximately 20 days and that protein intake has limited effect on albumin levels(91), monitoring any changes in postoperative recovery or response to nutritional support is limited. This is supported by a secondary analysis of an randomised controlled trial (RCT) in non-critically unwell medical patients which found albumin, although it predicted mortality, was not helpful for deciding which patients should receive nutritional support(96). In addition, a systematic review assessing the role of albumin in patients who were malnourished (mostly due to anorexia nervosa) but otherwise healthy, found that serum albumin remained stable despite severe malnutrition, indicated by a BMI of  $\leq 12$  after more than six weeks of starvation(97). Altogether, this makes it unreliable to be used as a marker for malnutrition.

A number of international bodies have advised against the use of albumin as a marker for malnutrition. The National Institute for Health and Care Excellence (NICE) recommend that low albumin is more likely to be a reflection of acute disease rather than malnutrition(98). The European Society for Clinical Nutrition and Metabolism (formerly the European Society of Enteral and Parenteral Nutrition, (ESPEN)) support this but reiterate hypoalbuminaemia is a surgical risk factor in its own right(43,99). The Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition (ASPEN) categorically state albumin and pre-albumin should not be used as nutrition markers(100). Finally, the Global Leadership Initiative on Malnutrition (GLIM), which includes representatives from ASPEN and ESPEN, as well as the Federacion Latino Americana de Terapia Nutricion Parental Y Enteral (FELANPE) and Parenteral and Enteral Nutrition Society of Asia (PENSA) state that albumin is a proxy marker of inflammation only(101).

## 1.3 Guidelines

### Definition of malnutrition

There is no universal definition for malnutrition in the literature or clinical guidelines(102,103). Malnutrition is often synonymous for undernutrition. However, it is important to remember that it also encompasses patients that have an inadequate balance of vitamins or minerals, are overweight or obese, or present with diet-related non-communicable diseases including cardiovascular disease and cancer. Many of these patients have emergency surgery. In fact, in a small study investigating perioperative morbidity and mortality in obese EGS patients (BMI (body mass index)  $\geq 35\text{Kg/m}^2$ ), morbidly obese patients had greater rates of reoperation, admission to ICU and longer length of stay than severely obese patients(104). This may be due to the patients having hidden malnutrition. This contradicts a large multicentre study however, whereby EGS patients who were overweight or obese had lower rates of mortality than patients of normal weight – ‘the obesity paradox’(105).

There are a number of national and international bodies that provide a definition of malnutrition(68,98,101,106,107) (**Table 1.4**). Except for the World Health Organisation (WHO), they have also produced guidelines tailored towards the provision of nutrition in EGS patients and so will be reviewed here to act as baseline upon which to consider the results from the two systematic searches later in this review.

Firstly, the WHO refers to *‘deficiencies, excesses, or imbalances in a person’s intake of energy and/or nutrients’*(68). It provides three broad categories including undernutrition, micro-nutrient related malnutrition and, overweight and obesity and diet-related non-communicable diseases.

Representing the UK, the NICE definition of malnutrition focuses purely on nutrition deficiencies(98). Criteria to diagnose malnutrition are also provided (**Table 1.4**). Using these criteria, it would seem many EGS patients will be identified as at risk of malnutrition because of their diagnosis and the subsequent surgical stress response. Patients may not be identified as malnourished however, as the cut-offs used for BMI may not be relevant with today’s population and increasing obesity trends(108). NICE recommend that patients identified as malnourished or at risk of malnutrition should be considered for nutritional support (oral, enteral, parenteral)(98). Almost all EGS patients undergoing major surgery such as an EL will therefore be classed as at risk of malnutrition and nutritional support ought to be offered.

To fulfil a diagnosis of malnutrition according to ESPEN, a two-step process is used(106). Patients are identified as being at risk of malnutrition using a validated tool and then they are assessed against specific criteria (**Table 1.4**). This was a Delphi process with representatives from different clinical specialties in over 40 countries, whereby following consensus of statements these were then put to the ESPEN membership. Although this approach is very encompassing, it is not yet validated specifically for EGS patients. Further, clinical experience suggests that many patients would not be classed as malnourished on these terms. Similar to NICE guidelines, the focus on weight loss, BMI and fat free mass index (FFMI) would be too narrow to capture those patients that require nutritional support.

However, the ASPEN consensus statement recognises a diagnosis of malnutrition if two of six criteria are met (**Table 1.4**)(107). ASPEN provide values for a diagnosis of non-severe or severe malnutrition, and in agreement with ESPEN, discuss three different contexts ('malnutrition syndromes') within which malnutrition should be considered. These include acute illness, chronic disease and social or environmental circumstances. This recognises that the aetiology of malnutrition may be variable for different patients. ASPEN specifically recognise situations when diagnosing malnutrition is inappropriate or difficult, including trauma (surgical) and critically unwell patients who may already be at risk on admission to hospital(107).

Finally, recently there has been a push for a global consensus for a diagnosis of malnutrition (**Table 1.4**)(101). Similar to ESPEN guidelines, GLIM devised a two-step process for risk screening and assessment(101). Risk screening is using a validated screening tool, followed by a second step for assessment to diagnose and assess severity of malnutrition. Once again, it is likely that EGS patients may be identified as at risk of malnutrition, but not malnourished, as the phenotypic criteria of low BMI or reduced muscle mass may not be reached. Unless the patient presents having deteriorated for a long time out of hospital prior to admission, having a phenotypic criteria may not occur until postoperatively after the catabolic stress response has taken its toll. An EGS patient may therefore be diagnosed as malnourished only at this late stage, and this be after the 'window' of opportunity to provide nutritional support, if one exists.

**Table 1.4:** Definitions of malnutrition

| Guidelines                           | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WHO, 2021(68)</b>                 | <i>'Malnutrition refers to deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients.'</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>UK guidelines</b>                 | <i>'A state in which a deficiency of nutrients such as energy, protein, vitamins and minerals causes measurable adverse effects on body composition, function or clinical outcome.'</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| NICE, 2006 (updated 2017)(98)        | Malnourished: <ul style="list-style-type: none"> <li>• Body mass index &lt;18.5Kg/m<sup>2</sup></li> <li>• Unintentional weight loss &gt;10% within last 3-6 months</li> <li>• BMI &lt;20Kg/m<sup>2</sup> and unintentional weight loss &gt;5% within last 3-6 months</li> </ul> At risk of malnutrition: <ul style="list-style-type: none"> <li>• Eaten, or are likely to eat, little or nothing for five days</li> <li>• A poor absorptive capacity/ high nutrient losses/ increased nutritional need</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>European guidelines</b>           | <i>'A state resulting from lack of uptake or intake of nutrition leading to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease.'</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| ESPEN, 2015(106)                     | Two step process: <ol style="list-style-type: none"> <li>1. Patient identified as at risk of malnutrition using a validated risk tool</li> <li>2. Patients need to have either: <ol style="list-style-type: none"> <li>a. a BMI of &lt;18.5Kg/m<sup>2</sup></li> <li>b. unintentional weight loss (&gt;10% indefinite of time or &gt;5% over 3 months) and at least one of either reduced BMI (&lt;20Kg/m<sup>2</sup> aged &lt;70years or &lt;22 kg/m<sup>2</sup> aged &gt;70 years) or a low fat free mass index (&lt;15Kg/m<sup>2</sup> in females and &lt;17 kg/m<sup>2</sup> in males)</li> </ol> </li> </ol>                                                                                                                                                                                                                                                                                                                                                                   |
| <b>American guidelines</b>           | Two of six criteria: <ul style="list-style-type: none"> <li>• Insufficient energy intake</li> <li>• Weight loss</li> <li>• Loss of muscle mass</li> <li>• Loss of subcutaneous fat</li> <li>• Fluid accumulation that may sometimes mask weight loss</li> <li>• Diminished functional status as measured by handgrip strength</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| ASPEN, 2012(107)                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>'Global' consensus guidelines</b> | Two step process: <ol style="list-style-type: none"> <li>1. Patient identified as at risk of malnutrition using a validated risk tool</li> <li>2. Diagnosis based on 1 phenotypic and 1 aetiologic criteria <ol style="list-style-type: none"> <li>a. Phenotypic criteria: <ol style="list-style-type: none"> <li>i. Non-volitional weight loss (&gt;5% within 6 months or &gt;10% beyond 6 months)</li> <li>ii. Low BMI (&lt;20 if &lt;70 years, &lt;22 if &gt;70 years)</li> <li>iii. Reduced muscle mass by a validated technique measured</li> </ol> </li> <li>b. Aetiologic criteria: <ol style="list-style-type: none"> <li>i. Reduced food intake or assimilation (≤50% energy requirements for &gt;1 week, or any reduction for &gt;2 weeks, or any GI conditions that adversely effects food assimilation of absorption)</li> <li>ii. Inflammation or disease burden (acute disease/ injury such as surgery or chronic disease-related)</li> </ol> </li> </ol> </li> </ol> |
| GLIM, 2018(101)                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

Abbreviations: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition (ASPEN); European Society for Clinical Nutrition and Metabolism (ESPEN); Gastrointestinal (GI); Global Leadership Initiative on Malnutrition (GLIM); National Institute for Health and Care Excellence (NICE); World Health Organisation (WHO). BMI units Kg/m<sup>2</sup>.

## **Nutrition screening and assessment**

NICE and ESPEN guidelines recommend nutritional screening on admission and throughout a patient's hospital stay; NICE advocate weekly screening for inpatients(98). ASPEN recommend screening within the first 48 hours of admission and a full assessment of patients admitted to ICU(109). All postoperative ICU patients should have their nutrition risk determined and it should not be based on visceral proteins(109).

Although NICE suggests the Malnutrition Universal Screening Tool (MUST) is an acceptable tool to screen for malnutrition in the UK, and is widely adopted, ESPEN recognises a number of tools that can be used in a hospital setting. These include the NRS 2002, the MNA-SF and MUST(106). ESPEN's guidelines on nutrition in critically ill patients advise a general clinical assessment of nutrition should be performed until a specific tool has been validated, although every patient in ICU for more than 48 hours should be considered high risk for malnutrition(99). On the contrary, ASPEN advise a nutritional risk screening using a tool such as the NRS 2002 and NUTRIC tools can be used in critically ill patients(109). Finally, the GLIM guidelines state that screening is performed using a validated screening tool, and although none is recommended, tools such as the NRS 2002, MNA-SF, MUST and the Subjective Global Assessment tool are presented(101).

## **Initiation of nutritional intervention**

There are no guidelines specifically focussed on the optimal nutritional intervention for EGS patients; the majority are based on elective patients where time constraints are less urgent. All guidelines discuss the mantra that oral intake is the preferred route to enteral nutrition (EN), and EN is the preferred route to parenteral nutrition (PN), unless there are contraindications.

Nutritional support is recommended for malnourished patients or those at risk of malnutrition within five days of admission according to NICE(98). No information is provided regarding exact timing of initiation of EN or PN in relation to date of surgery.

On the contrary, ESPEN and ASPEN recommend the initiation of 'early EN' (within 24-48 hours) in critically unwell patients, in order to maintain gut integrity and function and improve clinical outcomes including reduced infection, length of stay and mortality, although evidence quality is low(99,109). However, ICU patients who are at low nutrition risk and not critically unwell, nutritional support can be delayed for one week; few EGS patients after an EL would fulfil this criterion. Daily reassessment in this scenario is recommended. PN should be commenced in post-op patients who have undergone

major surgery, and if not high risk this would ideally be delayed for 5-7 days. Evidence suggests that patients are at increased risk of complications if started prior to this, although the evidence is based on elective cancer patients, and not EGS patients(110). Indeed, ASPEN recognise starting PN preoperatively in EGS patients is unlikely to be possible and so shortening the postoperative initiation date of PN can be considered, but only if its duration is likely to be longer than seven days(109). However, there is no benefit to starting supplementary PN in non-malnourished patients who are candidates for EN(111).

ESPEN guidelines are typically aimed at elective patients on an ERAS protocol, rather than emergency. A nutrition assessment (not screening) is recommended pre- and post-op(112). Nutritional support is recommended in patients who will be unable to eat for >5 days postoperatively(43), or those who cannot maintain >50% recommended intake for >7 days. This is likely to be a substantial number of EGS patients. ESPEN guidelines on EN and PN are targeted at elective patients(43,113). However, salient transferable recommendations include initiating PN only if oral/ enteral feeding is unlikely for seven days and the initiation of support immediately if a nutrition risk becomes evident(43).

## 1.4 Nutrition therapies

### Oral Nutritional Support

Oral nutritional support is the provision of food and fluid via the oral route to support patients at risk of malnutrition or who are malnourished(114). Oral nutrition support is often considered to be the first step in those identified as malnourished or at risk, and there has been much research into this with respect to elective general surgery patients. ERAS programs advocate minimising starvation times and carbohydrate loading pre-operatively, and then resuming normal oral nutrition swiftly post-operatively(26). However, there is minimal evidence in the emergency setting, and it would be regarded as unsafe in patients with intestinal failure which account for a large proportion of the EGS cohort. This is in addition to the impracticalities in the pre-operative phase when patients are acutely unwell, as well as the immediate post-operative phase when, for example, ileus (non-mechanical intestinal obstruction) is common and bowel rest recommended. Although there may be a role for post-operative oral nutritional support once the patient has recovered from the initial surgery and illness, it will not be considered any further in this thesis.

### Enteral and Parenteral Nutritional Support

Enteral nutrition (EN) or parenteral nutrition (PN) is considered when insufficient nutritional support can be maintained via the oral route(98). EN is the provision of nutritional support directly into the stomach or small bowel via a tube. This tube may be nasal, or via a tube through the abdominal wall which can be sited endoscopically, radiologically or surgically. PN is the provision of nutritional support intravenously, often through a large cannula in the neck (central line) or a peripheral vein (peripherally inserted central catheter). Different clinical scenarios would dictate which route is best, but EN is generally recommended prior to PN if there are no contraindications. This is because EN has several advantages beyond reduced risk of catheter-related bloodstream infections. Critical illness can result in a negative effect on gut motility and blood flow, and can cause increased intestinal permeability by altering mucosal integrity. EN can aid in preserving this intestinal barrier and function through complex mechanisms(115,116). It also maintains immunity(117) and limits dysbiosis(118), which is the loss of beneficial bacteria, overgrowth of pathogenic bacteria and a loss of bacterial diversity. Trophic EN feeding can achieve this by administering small volumes of EN that helps maintain intestine structure and function although it is not enough to meet full nutritional requirements. Additionally, there is paucity of evidence as to the exact timing (early vs delayed EN) of such approach in critical illness(119–121). Combining it with PN (supplemental PN, or dual nutrition) may help to ensure nutritional requirements are met(121,122).

As discussed previously, outcomes are known to be worse in EGS patients in comparison to elective patients. Given the long term intention is to change clinical practice such that malnourished EGS patients can be appropriately identified and subsequently offered the nutritional support needed, it would be pertinent to examine, albeit briefly, the quality and impact of enteral and parenteral nutrition interventions in the EGS cohort. The remaining of this chapter presents a summary of the literature for enteral and parenteral nutrition in operatively managed EGS patients. Randomised controlled trials in adult patients who received either enteral nutrition, parenteral nutrition, or a combination, were considered. There was attention on five areas of interest, including: the study population; the definition(s) of malnutrition in research; the use of nutrition screening tools or assessment; what nutrition regimes are trialled; and, what primary outcomes are commonly reported. Studies whereby patients were managed conservatively, cancer resections not performed as an emergency and trauma laparotomies are not included here as they do not correspond to the underlying project population of NELA-eligible EGS patients.



## **Enteral nutrition in operatively managed EGS patients**

This evidence summary examines the evidence for enteral nutrition in operatively managed EGS patients. In total, there are 15 studies comprising of 1,849 patients, of which at least 703 were EGS patients(**Table 1.5**)(123–137).

### **Study population**

There are five studies focussed solely on the non-traumatic EGS patient group(129,131,134–136), while five studies were a mix of surgical and medical patients(123,125,126,128,132). The remaining studies were a mix of patients from different surgical specialties, included elective as well as EGS patients, or patients that were managed by conservative and operative pathways(124,127,130,133,137). The surgical diagnosis was made clear in eight studies(129–131,133–137).

Evidently, the study population typically recruited to RCTs in the EGS domain remains small with wide variation. This likely reflects difficulty in recruitment to studies, which may be for various reasons. EGS patients are a very heterogeneous population with a complex patient journey(138). As discussed previously, there are many surgical diagnoses with different treatment pathways, and especially in the emergency setting, time may hinder recruitment of a homogenous population. Further, some patients may be admitted to critical care, whereby access to nutritional intervention may be more efficient, or decisions more protocol-driven than with ward-based patients. Indeed this was the objective in the study by Martin et al, a cluster-RCT involving 14 hospital ICUs, testing the implementation of evidence-based algorithms for nutrition intervention(132). Altogether, this may explain why there are so few studies focussed purely on EGS patients. Studies that also include medical patients or patients from other surgical specialties are a very distinct population from the general surgical population, a sentiment echoed by Nally et al(14).

### **Study design**

There was a wide distribution of studies across 10 countries (including Thailand, India, Germany, Canada, Japan, Australia, Latvia, China, United States of America (USA), France); one third of all studies were undertaken in India(129–131,133,136). It is great that nutrition in EGS patients is a global research interest; however it is surprising that more studies have not been performed in countries with guidelines from representing bodies such as NICE, ESPEN and ASPEN. There are no studies originating in the UK, and only a couple of studies in European countries and the USA.

Multicentre studies ought to lead to larger sample sizes with greater external validity than single centre studies(139). Despite six multicentre studies(125,127,128,131–133), there was only a total of 267 definite EGS patients enrolled within all these studies combined (not including Martin et al(132), Yeh et al(125) or Peake et al(127), as although emergency surgical patients were enrolled in these studies, it is not known to what proportion were EGS patients, or emergency patients admitted under other surgical specialties) (**Table 1.5**). Of these studies, one was a pilot study assessing Enhanced Protein-Energy Provision via the Enteral Route Feeding Protocol (PEP uP) in surgical/ trauma patients(125). Slow recruitment across the three hospitals over two years (36 patients in total; 0.1 patient/site/week) meant the trial was ended early by the sponsor. It seems consenting was a major issue with 92/128 (71.8%) patients not consented, primarily because there was no next of kin available. Even in those approached, 20% of substitute decision makers refused consent for enrolment. Peake et al was a feasibility trial across 5 centres for 14 weeks with a high recruitment rate of 1.6 patients/site/week (112 patients enrolled) and experienced a much smaller refusal of consent rate(127). However, a very small proportion (14%) of patients were emergency surgical patients, with a likely even smaller EGS population. Elke et al describe a secondary analysis of the VISEP (Efficacy of Volume Substitution and insulin therapy in Severe Sepsis) study(128). This was a large, multicentre RCT across 18 tertiary centres conducted over two years and two months, originally comparing intensive and conventional insulin therapies and hydroxyethyl-starch with Ringer's lactate for volume resuscitation. The secondary analysis identified 353 patients (0.2 patients/site/week) who had received nutritional support, of which 137 were EGS patients. This trial design meant the number of patients receiving PN only (n = 25) was small, and so any meaningful statistical analysis was limited, as is its ability to draw conclusions with external validity.

Another difficulty with multicentre studies is the compliance to a protocol, as experienced by Martin et al(132). Recruitment of patients was across 14 hospitals over one year (462 patients in total; 0.6 patients/site/week), however one hospital declined to comply with the study intervention having been randomly assigned to the intervention group. In contrast, smaller multicentre studies demonstrated by Saluja et al(133) and Kaur et al(131) demonstrated reasonable patient recruitment (0.6 patient/site/week, and one patient/site/week, respectively), with a large proportion of these EGS patients (50% and 100%, respectively).

Finally, the importance of blinding and minimising bias within RCTs, as well as many of the difficulties encountered in surgery specifically, have been well described(140,141). However, only four studies offered any information on blinding(123,124,127,130). Two studies made use of observer/ outcome

analysts blinding, although the exact method is not described in detail(123,130). Again, no detail is provided regarding the method of patient blinding used by Chinda et al(124). Peake et al describe double blinding in a surgical study, whereby study interventions had indistinguishable packaging, which is a very reasonable method that could be utilised by other nutritional intervention studies(127). Various methods of blinding in surgical trials are recognised(142), and it is vital to ensure high-quality studies in the EGS population.

**Table 1.5:** RCTs including EGS patients receiving enteral nutrition (EN)

| Author & Year               | Study participants             | General Surgical Diagnosis                                                                                                                            | Total patients (EGS patients)                                       | Blinding                                      | Definition of malnutrition                                                         | Screening/ assessment/ dietitian                                                     | Nutrition regime                                                                                                    | Primary outcome measure                                                            | Comments                                                                                                              |
|-----------------------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Nakamura, 2020</b> (123) | Surgical/ medical              | Not known                                                                                                                                             | 117 (46)                                                            | Outcome analysts blinded                      | BMI <18.5 or presumed recent body weight loss >10% or each physician's decision    | None                                                                                 | Intervention: high-protein 1.8 g/kg/day<br>Control: medium-protein 0.9 g/kg/day                                     | CT femoral muscle volume change (%) day 1 vs day 10                                | -                                                                                                                     |
| <b>Chinda, 2020</b> (124)   | Mixed surgical                 | 'Intra-abdominal/ extra-abdominal/ vascular operation'                                                                                                | 170 (95 intra-abdominal)                                            | Patient blinding                              | NRS-2002 of $\geq 3$<br>MUST of $\geq 2$<br>NUTRIC of $\geq 5$                     | NRS-2002<br>MUST<br>NUTRIC                                                           | Intervention: 'Siriraj Surgical ICU Nutrition Protocol'<br>Control: clinical judgements                             | Effectiveness of the Siriraj Surgical ICU Nutrition Protocol                       | Excluded were patients who were tolerating an oral diet or were scheduled to return to an oral intake within 24 hours |
| <b>Yeh, 2019</b> (125)      | Trauma/ surgical/ neurological | Not known                                                                                                                                             | 36 (7 general surgery; 30 emergency surgical patients, EGS unknown) | None                                          | None                                                                               | None                                                                                 | Intervention: Protein-Energy Provision via the Enteral Route Feeding Protocol (PEP uP)<br>Control: standard of care | Nutrition adequacy over the first 12 ICU days                                      | Small numbers<br>Trial ended early                                                                                    |
| <b>Xi, 2017</b> (126)       | Surgical/ medical              | Not known                                                                                                                                             | 125 (30)                                                            | None                                          | None                                                                               | None                                                                                 | Intervention: pectin-supplemented EN<br>Control: EN                                                                 | 30-day mortality and gastrointestinal intolerance                                  | Small, single-centre                                                                                                  |
| <b>Peake, 2014</b> (127)    | Surgical                       | Emergency operative<br>Emergency non-operative<br>Elective operative                                                                                  | 112 (16 emergency surgical patients, EGS unknown)                   | Patients, clinicians, and all study personnel | None                                                                               | Dietitian assessment (fixed prescription of 20–25 kcal/kg or Schofield's equation)   | Intervention: 1.5 kcal/mL EN<br>Control: 1.0 kcal/mL EN                                                             | Daily calorie delivery (kcal/d) for 10 days                                        | 5 tertiary ICUs, ITT analysis                                                                                         |
| <b>Elke, 2013</b> (128)     | Surgical/ medical              | Not known                                                                                                                                             | 353 (137)                                                           | None                                          | None                                                                               | Harris–Benedict equation without activity adjustment to calculate BEE                | EN vs PN vs EN + PN                                                                                                 | Comparison outcomes of three nutritional strategies                                | Secondary analysis of VISEP trial data (septic patients), ITT, 55.3% surgical patients with EN+PN had no surgery      |
| <b>Doley, 2009</b> (129)    | Surgical                       | Severe acute pancreatitis                                                                                                                             | 50 (29)                                                             | None                                          | None                                                                               | None                                                                                 | Intervention: PN Control: EN                                                                                        | Not stated (includes inflammatory markers, serum albumin)                          | Nutritional support continued for $\geq 14$ days                                                                      |
| <b>Kumar, 2007</b> (130)    | Surgical                       | Bowel perforation, abdominal trauma                                                                                                                   | 120 (93, excluding 27 trauma patients)                              | Observer blind                                | None                                                                               | None                                                                                 | Intervention: Enteral glutamine 45g/day for 5 days + standard care<br>Control: standard care alone                  | Not stated                                                                         | Age significant difference in groups; unclear exactly numbers that had surgery                                        |
| <b>Kaur, 2005</b> (131)     | Surgical                       | Exploratory laparotomy for non-traumatic perforation peritonitis (DU, ileal perforation (TB, typhoid), appendicitis, GU, caecal (amoebic typhilitis)) | 100 (100)                                                           | None                                          | NRI < 100 or current weight < 95% of the ideal weight and serum albumin at 39.2g/L | Weight, height, mean arm circumference, handgrip strength, albumin, lymphocyte count | Intervention: EN feed started 24 hours post-surgery<br>Control: oral intake once passed flatus                      | Not stated (includes effect on nutritional status, sepsis score and complications) | Hospital kitchen-prepared feed; weight and pathology not exactly comparable to most Western patients                  |

|                            |                   |                                                                                                                                  |                                                                           |      |                                                                         |                                                                                                                                                |                                                                                                      |                                                                                                 |                                                                                                                              |
|----------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| <b>Martin, 2004</b> (132)  | Surgical/ medical | Not known                                                                                                                        | 462 (133 general surgery; 154 emergency surgical patients, EGS not known) | None | None                                                                    | None                                                                                                                                           | Testing evidence based nutritional algorithms                                                        | Hospital mortality, length of ICU stay and length of hospital stay                              | -                                                                                                                            |
| <b>Saluja, 2002</b> (133)  | Surgical          | Perforation (ileal, DU), TB, GI cancer, ileostomy, trauma, CBD exploration                                                       | 60 (30 exc TB, GI cancer, ileostomy, trauma, CBD exploration)             | None | NRI < 100 or current weight < 95% of the ideal weight and serum albumin | Weight, height, mean arm circumference, handgrip strength, albumin, lymphocyte count                                                           | Intervention: standard ward diet + 500ml oral (protein + energy) feed<br>Control: standard ward diet | Not stated (includes effect on nutritional status, sepsis score and complications)              | Borderline, moderate and severe groups, with and without supplementation, aged 20-60                                         |
| <b>Pupelis, 2001</b> (134) | Surgical          | Severe acute pancreatitis or peritonitis due to GI perforation and bowel ischaemia                                               | 60 (60)                                                                   | None | None                                                                    | None                                                                                                                                           | Intervention: EN feeding<br>Control: normal diet                                                     | Not stated (include SIRS, MODS, complications, mortality)                                       | Hospital kitchen—prepared feed; started within 12h of ICU admission                                                          |
| <b>Pupelis, 2000</b> (135) | Surgical          | Severe acute pancreatitis (infected necrosis, pancreatic abscess, infected pseudocyst, postnecrotic pseudocyst)                  | 29 (29)                                                                   | None | None                                                                    | None                                                                                                                                           | Intervention: IV fluids and EN<br>Control: IV fluids                                                 | Not stated (includes LOS, calorie intake, whether EN was 'successful', morbidity and mortality) | Started within 24h of operation                                                                                              |
| <b>Singh, 1998</b> (136)   | Surgical          | Exploratory laparotomy for non-traumatic perforation peritonitis (stomach, duodenum, jejunum, ileum due to typhoid fever and TB) | 43 (43)                                                                   | None | None                                                                    | Anthropometric indices (weight, triceps skinfold thickness, and mid-arm circumference) and serum albumin levels. on admission, day 4 and day 7 | Intervention: IV fluids and EN<br>Control: IV fluids                                                 | Not stated (includes clinical course, morbidity and mortality)                                  | Feeding jejunostomy; Started within 24h of operation; higher sepsis score in study group; nutritionally matched on admission |
| <b>Ziegler, 1990</b> (137) | Surgical          | Emergency laparotomy (peritonitis, tumour, trauma, obstruction)                                                                  | 12 (11, excluding 1 trauma laparotomy)                                    | None | None                                                                    | None                                                                                                                                           | Intervention: Protein hydrolysate (PH) diet<br>Control: non-degraded protein (NDP) diet              | Not stated (inc amino acid and protein levels, and urine/ chyme/ faeces/ nitrogen excretion)    | TPN initially post-op; self-controls                                                                                         |

Abbreviations: basal energy expenditure (BEE); common bile duct (CBD); duodenal ulcer (DU); Efficacy of Volume Substitution and Insulin Therapy in Severe Sepsis (VISEP) trial; enteral nutrition (EN); gastrointestinal (GI); genito-urinary (GU); intensive care unit (ICU); intention to treat analysis (ITT); intravenous (IV); length of stay (LOS); Malnutrition screening tool (MUST); multiple organ dysfunction syndrome (MODS); Nutritional risk in critically ill (NUTRIC); Nutritional risk score-2002 (NRS-2002); parenteral nutrition (PN); systemic inflammatory response syndrome (SIRS); tuberculosis (TB).

### **Definition(s) of malnutrition**

Only four studies(123,124,131,133) detailed which definition of malnutrition was used (**Table 1.5**). Three studies used similar criteria as detailed by ASPEN for the definition of malnutrition(131,133,136), but did not specifically diagnose malnutrition using the guidelines. No RCT has used the most recent GLIM criteria for the definition of malnutrition, although these were published only three years ago. As previously discussed, the variance in patient inclusion criteria makes it difficult to compare studies. Patients may be defined by one study as malnourished and not by another. As such, meaningful interpretation of any outcomes will require caution.

### **Use of nutrition screening tools or assessment**

Only one study(124) reported using screening tool as recommended by current guidelines for malnutrition (**Table 1.5**). Chinda et al used MUST (recognised by NICE and ESPEN guidelines(98,106)), and NRS 2002 and NUTRIC (recognised by ASPEN for use in critical care(109)). One study referred to a dietitian for assessment(127). In the UK, a large cohort study identified 55% of patients with small bowel obstruction and a high risk of malnutrition, as determined by the NRI, were referred for dietitian input(50). This is despite ten studies(123,124,126–129,132,134,135,137) involving patients treated in the intensive care unit (ICU), and a known significantly increased mortality for any degree of malnutrition in these patients(8). The importance of appropriate screening followed by a full assessment for malnutrition in EGS patients, to allow risk stratification, cannot be understated. This is likely to aid decision making for subsequent nutritional intervention, and therefore giving some of the most at risk EGS patients the best chance of survival.

### **Nutrition implementation**

The timing of implementation, nutrition regime and formulation was different in all studies (**Table 1.5**). Although beyond the scope of this evidence summary, it is worth noting the wide variety. This likely emphasises that the most suitable approach is unknown and requires further research.

### **Primary outcomes reported**

Over half the studies did not detail a primary outcome (**Table 1.5**). Where primary outcomes were published, major differences in study population and study design makes comparing outcomes difficult. In addition to this, some outcomes may be affected by ascertainment bias given the majority of the studies did not involve any form of blinding. However, in order to attempt some degree of comparison amongst the studies, the author selected results for nosocomial infection, length of stay and mortality (if published results available). It is clear there is wide variance and interestingly, there

were very few statistically significantly results despite the known impact of malnutrition in EGS patients (**Table 1.6**). The development of a core outcome set would greatly benefit this area of research(143).

**Table 1.6:** Key outcomes in RCTs including EGS patients receiving EN

| Author & Year               | Nosocomial infection,<br>% (n) |                  | ICU length of stay,<br>days (IQR) |                  | ICU mortality,<br>% (n) |                  |
|-----------------------------|--------------------------------|------------------|-----------------------------------|------------------|-------------------------|------------------|
|                             | Intervention<br>group          | Control<br>group | Intervention<br>group             | Control<br>group | Intervention<br>group   | Control<br>group |
| <b>Nakamura, 2020</b> (123) | 35.6 (21)                      | 50.9 (29)        | 7 (5-12)                          | 9 (6-13)         | -                       | -                |
| <b>Chinda, 2020</b> (124)   | 20.0 (17)                      | 14.1 (12)        | 6 (4–13)                          | 6 (3–13)         | 11.8 (10)               | 17.6 (15)        |
| <b>Xi, 2017</b> (126)       | 11.3 (7)                       | 14.3 (9)         | 13 (-)                            | 17 (-)           | 1.6 (1)                 | 4.8 (3)          |
| <b>Peake, 2014</b> (127)    | -                              | -                | 9 (5-22)                          | 11 (6-22)        | 11.0 (6)                | 16.0 (9)         |
| <b>Elke, 2013</b> (128)     | -                              | -                | 30 (16-54)                        | 20 (13-28)       | 24.4 (59)               | 12.8 (11)        |
| <b>Doley, 2009</b> (129)    | 60.0 (15)                      | 64.0 (16)        | 10 (0-44)                         | 15 (0-60)        | 16.0 (4)                | 20.0 (5)         |
| <b>Kumar, 2007</b> (130)    | 70.0 (44)                      | 65.0 (37)        | -                                 | -                | 12.7 (8)                | 8.8 (5)          |
| <b>Kaur, 2005</b> (131)     | 66.0 (33)                      | 70.0 (35)        | -                                 | -                | -                       | -                |
| <b>Martin, 2004</b> (132)   | -                              | -                | 10 (-)                            | 11 (-)           | 27.0 (-)                | 37.0 (-)         |
| <b>Pupelis, 2001</b> (134)  | 6.7 (2)                        | 26.7 (8)         | 13 (-)                            | 16 (-)           | 3.3 (1)*                | 23.0 (7)*        |
| <b>Pupelis, 2000</b> (135)  | 45.0 (5)                       | 28.0 (6)         | 7 (-)                             | 6 (-)            | -                       | -                |
| <b>Singh, 1998</b> (136)    | 14.0 (3)                       | 36.0 (8)         | -                                 | -                | -                       | -                |

Details regarding nutrition regime (intervention and control groups) in each study are available in **Table 1.5**. \*statistically significant results. Abbreviations used: intensive care unit (ICU); interquartile range (IQR); number of patients (n). Only EN + PN vs EN groups compared in Elke et al. Nosocomial infection refers to pneumonia and relates to combined terms: ‘infectious complications’(126); ‘pneumonia/ pulmonary infection’(123,124,134–136); ‘wound infection and chest infection’(131).

## Parenteral nutrition in operatively managed EGS patients

The same approach as described above for EN was implemented to best understand the evidence base for PN in operatively managed EGS patients. There are 8 studies comprising of 756 patients, of which at least 358 were EGS patents, included in this evidence summary(124,129,144–149) (**Table 1.7**).

### Study population

Three studies focussed entirely on the non-traumatic EGS patient, all with a diagnosis of pancreatitis(129,145,147) (**Table 1.7**). Three studies included patients that were medical and surgical(144,148,149). The remaining two studies were studies with a patients whom were a mix of surgical specialties(124,146). All the studies had fewer than 100 EGS patients.

As with studies of EN in operatively managed EGS patients, PN studies were small and a wide variation existed in patient mix. Interpreting outcomes in these studies and making any subsequent analysis is not feasible. Although challenges of patient recruitment were not discussed in the majority of included studies, it was evidently problematic in some studies. Despite only approximately 4% of patients (7/175) withdrawing consent after randomisation in the study by Grau-Carmona, almost a fifth of patients (597/3429) declined to participate in the study from the very start(149). Similarly, de Chalais et al detail that of the 50 included patients in their study, 32 were excluded from the analysis for a variety of reasons(148). Finally, Estivariz et al experienced problems in their pilot study with drug availability and so the trial was temporarily paused for more than one year(145). Overall, 63 patients were enrolled (of which four patients were excluded) in five and a half years, not including the stoppage time. Study design involving consent issues, which largely impacts patient recruitment and retention, will be important to consider in any of my own future studies.

Further, as highlighted previously, three of the studies focussed on patients with severe acute pancreatitis. Pancreatitis is a common diagnosis in EGS, and nutrition in this patient group is important to consider(150). These three studies were included as they met the inclusion criteria of this systematic search (operatively managed EGS patients). However, EL for pancreatitis is comparatively much rarer than other reasons for laparotomies, and indeed is a specific exclusion criterion for NELA(24). Interpretation of these studies in context is therefore vital.

### Study design

Studies were globally distributed (Thailand, USA, India, United Kingdom, Hungary, South Africa). There were two multicentre studies(144,149) (**Table 1.7**). The most recent of these was a study by Grau-



Carmona et al investigating the effect of n-3 polyunsaturated fatty acids (found in fish oils) on nosocomial infections in medical and surgical critically ill patients(149). Inclusion criteria were broad: >18 years old, admitted with an APACHE II score  $\geq 13$  and whom were expected to have PN for >5 days. A total of 175 patients were recruited, of which 159 patients were included in intention-to-treat analysis. This was from 17 Spanish ICUs over four and a half years, representing a slow recruitment rate (0.04 patients/site/week). There was a six month follow up period. As well as being a small percentage of the 3,610 consecutive ICU patients who received PN during the recruitment period, it is a much smaller recruitment rate than would be expected for a large multicentre study. However, the study was terminated early for two reasons. Firstly, the recruitment period was longer than planned due to difficulties in recruiting patients early in their hospital stay. Second, a planned interim analysis identified that the prevalence of the primary outcome (nosocomial infection) was much lower than powered for, meaning a much larger sample size and even longer recruitment period would be needed. The authors consider this was due to the recent campaigns for reducing infection rates. It is clear that to truly identify the impact of specific nutritional regimes in the EGS population, a very large multicentre, and possibly international, trial would be needed.

Although not a multicentre study, it is worth noting that Carroll et al describe a small study of 19 patients recruited over 18 months investigating the role of PN with glutamine and growth hormone on protein metabolism in critically ill patients(146). Similarly to Grau-Carmona et al, it was also terminated early. This is because a large, multicentre study published results during the recruitment phase of Carroll et al showing growth hormone is associated with increased mortality(151).

The second multicentre study was by Umpierrez et al and considered the benefits of soybean oils (fish oils) versus olive oil-based PN in medical and surgical patients(144). This study involved two hospitals based within the same city, and so the study population is likely to be very similar, and so probably ought to be considered as a single centre study. In contrast to the EN systematic search, half the studies were blinded(124,144,145,149).

**Table 1.7:** RCTs including EGS patients receiving parenteral nutrition (PN)

| Author & Year                   | Study participants    | General Surgical Diagnosis                                                              | Total patients (EGS)                                         | Blinding         | Definition of malnutrition                                     | Screening/ assessment/ dietitian | Nutrition regime                                                                                                            | Primary outcome measure                                              | Comments                                                                                                              |
|---------------------------------|-----------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------|------------------|----------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Chinda, 2020</b> (124)       | Mixed surgical        | 'Intra-abdominal/ extra-abdominal/ vascular operation'                                  | 170 (95 intra-abdominal)                                     | Patient blinding | NRS-2002 of $\geq 3$<br>MUST of $\geq 2$<br>NUTRIC of $\geq 5$ | NRS-2002<br>MUST<br>NUTRIC       | Intervention: 'Siriraj Surgical ICU Nutrition Protocol'<br>Control: clinical judgements                                     | Effectiveness of the Siriraj Surgical ICU Nutrition Protocol         | Excluded were patients who were tolerating an oral diet or were scheduled to return to an oral intake within 24 hours |
| <b>Grau-Carmona, 2015</b> (149) | Surgical/ medical     | Not stated                                                                              | 159 (83 surgical (70 urgent); 76 medical)                    | Double blinding  | None                                                           | NRI                              | Intervention: PN with study lipid emulsion<br>Control: PN with control lipid emulsion                                       | Prevalence of nosocomial infections during 28 days of ICU stay       | Multicentre (17 Spanish ICUs). PN if expected to need if it for >5 days                                               |
| <b>Umpierrez, 2012</b> (144)    | Surgical/ medical     | Trauma (39.6%), major gastrointestinal (48.4%), or oncological surgery (12 %)           | 100 (89 surgical, 9 medical, 1 other)                        | Double blinding  | None                                                           | Not stated                       | Intervention: soybean oil-based PN<br>Control: olive oil-based PN                                                           | Incidence of new nosocomial infections                               | Culture-proven infection only                                                                                         |
| <b>Doley, 2009</b> (129)        | Surgical              | Severe acute pancreatitis                                                               | 50 (29)                                                      | None             | None                                                           | None                             | Intervention: PN<br>Control: EN                                                                                             | Not stated (includes inflammatory markers, serum albumin)            | Nutritional support continued for $\geq 14$ days                                                                      |
| <b>Estivariz, 2008</b> (145)    | Surgical              | Pancreatectomy for necrotizing pancreatitis (also cardiac, vascular and colon surgery)  | 59 (30 pancreatectomy for pancreatitis, 29 other surgery)    | Double blinding  | None                                                           | 'NST assessed'                   | Intervention: isocaloric, isonitrogenous glutamine dipeptide supplemented PN<br>Control: standard PN                        | Incidence of nosocomial infections                                   | NST assessed likely to need PN >7 days<br>Study paused part way due to drug availability                              |
| <b>Carroll, 2004</b> (146)      | Mixed surgical/ other | Emergency abdominal surgery (9) gastrointestinal obstruction (4) postcardiac arrest (1) | 19 (12 EGS, 6 AAA repair, 1 cardiac arrest)                  | None             | None                                                           | None                             | PN vs PN with glutamine vs TPN with glutamine, growth hormone and IGF-I                                                     | Protein metabolism in fasting and after 3 days of nutrition support  | Included if nutritional support needed for >3 days                                                                    |
| <b>Olah, 2002</b> (147)         | Surgical              | Acute pancreatitis, some patients surgically managed                                    | Phase 1: 89 (16 had surgery)<br>Phase 2: 92 (10 had surgery) | None             | None                                                           | None                             | Phase 1: PN vs EN<br>Phase 2: PN (patients in phase 1 as historical controls) vs EN and antibiotic in necrotic pancreatitis | Rate of septic complications (infected pancreatic necrosis, abscess) | Two phases in study. PN for minimum of 5 days                                                                         |
| <b>De Chalain, 1992</b> (148)   | Critically ill        | Peritonitis (DU, appendicitis)                                                          | 18 (7 EGS, 5 trauma, 3 AAA, 3 other)                         | None             | None                                                           | None                             | Intervention: glucose and fat<br>Control: pure glucose                                                                      | Protein metabolism                                                   | Patients required PN and mechanical ventilation for >4 days; crossover trial with 4 days on each regime               |

Abbreviations used: abdominal aortic aneurysm (AAA); duodenal ulcer (DU); enteral nutrition (EN); gastrointestinal (GI); intensive care unit (ICU); intention to treat analysis (ITT); Malnutrition screening tool (MUST); multiple organ dysfunction syndrome (MODS); Nutrition Risk Index (NRI); Nutrition support team (NST); Nutritional risk in critically ill (NUTRIC); Nutritional risk score-2002 (NRS-2002); parenteral nutrition (PN); systemic inflammatory response syndrome (SIRS).

## **Definition(s) of malnutrition**

Only one study defined malnutrition, which was Chinda et al and was discussed in the EN systematic search section(124) (**Table 1.7**). Although the definition of malnutrition remains to be an evolving term, its concept has been in the literature for many years, and certainly during the time these RCTs have been published.

## **Use of nutrition screening tools or assessment**

One study(124) used a recognised screening tool, as previously discussed. No screening tool was used by Estivariz et al(145), however, in this study a NST assessed patient eligibility for PN. NSTs are typically teams of dietitians, nurses, pharmacists and a doctor (gastroenterologist, surgeon, intensivist) aimed at optimising a patient's nutrition during their hospital stay(152–155). These are recommended by NICE(98) and ASPEN(109). ESPEN recommend NSTs for medical patients(156), but there are no guidelines for surgical patients. While there is high prevalence of these in the UK with approximately 80% of trusts having an NST(157), they are far less prevalent elsewhere based on a survey of ASPEN respondents(158). A recent systematic review of NSTs identified that the current evidence base is weak despite a tendency to support their implementation(152). This is in terms of effectiveness (selection of patients, inappropriate use of EN/PN, reducing the EN/PN ratio), reduction of complications due to nutritional support, or cost savings. Finally, Grau-Carmona et al describe the use of the NRI in their study, but this is only to compare baseline characteristics of included patients, and not identify the patients at risk of malnutrition or to stratify them to study arms(149).

The importance of appropriate screening followed by a full assessment for malnutrition in EGS patients appears to have been a missed opportunity. Future studies ought to clearly define this element as part of their strategy for patient inclusion criteria.

## **Nutrition regimes and implementation**

Once again, each study tested a different nutritional regime and criteria for implementation of PN (**Table 1.7**). Studies started PN if it was expected to be needed for more than three days(146), five days(147,149), seven days(145) and in Doley et al, it was continued for a minimum of 14 days in all patients(129). De Chalain did a crossover study whereby patients received both nutrition regimes for four days each(148). Clearly, implementation of PN did not follow guidelines.

## Primary outcomes reported

Only two studies report outcomes of the RCT in line with Consolidated Standards of Reporting Trials (CONSORT) guidelines(124,150), despite all except de Chalain et al being able to as the first outcome reporting guidelines were published in 1996(159). The commonest primary outcome was the prevalence of nosocomial infection(144,145,149). There were no statistically significant results related to these outcomes in each of the studies.

Again, in order to highlight the disparity of results amongst the studies, the author selected results for nosocomial infection, ICU length of stay and ICU mortality (if published results available) (**Table 1.8**). The development of a core outcome set may greatly benefit this area of research, and have recently been produced(143,160).

**Table 1.8:** Key outcomes in RCTs including EGS patients receiving PN

| Author & Year                   | Nosocomial infection, % (n) |               | ICU length of stay, days (IQR) |               | ICU mortality, % (n) |               |
|---------------------------------|-----------------------------|---------------|--------------------------------|---------------|----------------------|---------------|
|                                 | Intervention group          | Control group | Intervention group             | Control group | Intervention group   | Control group |
| <b>Chinda, 2020</b> (124)       | 20.0 (17)                   | 14.1 (12)     | 6 (4-13)                       | 6 (3-13)      | 11.8 (10)            | 17.6 (15)     |
| <b>Grau-Carmona, 2015</b> (149) | 10.5 (7)                    | 21.9 (14)     | 12 (-)                         | 18 (-)        | 32.5 (26)            | 20.5 (16)     |
| <b>Umpierrez, 2012</b> (144)    | 10.2 (5)                    | 13.7 (7)      | 15.2 (-)                       | 17.0 (-)      | 16.3 (8)             | 9.8 (5)       |
| <b>Doley, 2009</b> (129)        | 60.0 (15)                   | 64.0 (16)     | 10 (0-44)                      | 15 (0-60)     | 16.0 (4)             | 20.0 (5)      |
| <b>Estivariz, 2008</b> (145)    | 46.7 (7)*                   | 23.5 (4)*     | 12 (-)                         | 23 (-)        | -                    | -             |
| <b>Olah, 2002</b> (147)         | -                           | -             | -                              | -             | 2.2 (2)              | 8.3 (4)       |

Details regarding nutrition regime (intervention and control groups) in each study are available in **Table 1.7**. \*statistically significant results. Abbreviations used: intensive care unit (ICU); interquartile range (IQR); number of patients (n). Only the pancreatic necrosis surgery subgroup results are shown(145). As Olah et al was a two phase study, the control group is represented as the 'PN group' (patients in phase 1 as historical controls) and the intervention group is represented as the 'EN and antibiotic in necrotic pancreatitis' group(147). Nosocomial infection refers to pneumonia and relates to combined terms: 'pneumonia'(124,144); 'mechanical ventilation-associated pneumonia'(149); 'wound infection and chest infection'(145) and 'infection'(129).

## 1.5 Researcher reflexivity

I am acutely aware that my experiences as a surgical registrar and rotating through many organisations during my training has exposed me to a range of clinical experiences in identifying and managing nutrition in EGS patients. These experiences underpin my motivation to pursue this topic, and have shaped the development of this project. I summarise two memorable situations below.

Firstly, there have been situations where I would have been keen to 'build up' a patient's nutritional intake sooner than a colleague, occasionally a consultant colleague, would have done themselves. But I also noticed a difference between senior colleagues as well. Early in my registrar training, this seemed most apparent in the post-operative management of perforated duodenal ulcers. For two similar cases, one consultant would allow clear fluids from day one post-operatively, while another would keep the patient nil by mouth and referred the patient for nutritional support until sure there would be no leak.

The next case is of a young, fit and well patient who had ischaemic small bowel secondary to a band adhesion starting 4cm from the duodenojejunal flexure. While assisting the consultant form the anastomosis, I asked whether we should place a nasojejun tube to allow feeding if required. 'That is a secondary consideration. This anastomosis must work' was the response. The patient had an unremarkable recovery and required no nutritional intervention. While it may be that the consultant was right, and if there was a leak then parenteral nutrition could have been provided regardless, it highlighted that nutrition was often an afterthought.

I was finding it difficult to comprehend what should be done in particular situations and why there were differences between surgeons. Initially, it made sense to look introspectively; it was a deficiency of my own learning. However, I have also learned that where there is a difference in management of a problem, it is often because there is no consensus to managing that problem, and that often stems from a lack of evidence.

## 1.6 The gap in knowledge

The successful management of a patient's nutritional status, and malnutrition, is of paramount importance particularly in the EGS context where the stakes are higher and the challenges more intense. The failure to do so leads to an increased risk of complications and mortality for patients, and higher financial costs for the NHS. The James Lind Alliance (JLA), which is supported by the National Institute for Health Research (NIHR), recognise the need to improve perioperative care in emergency surgery<sup>(161)</sup> and garner an understanding of how to prevent adult malnutrition in vulnerable groups<sup>(162)</sup>.

The first step to managing malnourished EGS patients is the timely recognition of them. In the context of no agreed international definition of malnutrition, it is not surprising the literature review of EN and PN in EGS demonstrates an apparent wide range in defining and managing the nutritional status of patients in EGS. However, the extent of variation in practice among clinicians, and if present an understanding of its existence, has not previously been explored.

## 1.7 Chapter summary

Throughout this introduction and literature review of EN and PN, it has been demonstrated there are numerous reasons why research in EGS is important, along with some unmistakable challenges.

- *The EGS population are at high risk for malnutrition.* There are many causes of malnutrition in surgical patients. The current incidence of malnutrition in EGS patients may be as high as 40-60% of admissions. Identifying the highest risk groups requires appropriate screening using validated tools, followed by an assessment of nutritional status. Surgery increases a patient's nutritional demands as it is a catabolic process, and nutritional support presents an opportunity to attenuate this.
- *The EGS diagnoses are diverse.* Recognising the impact this heterogeneity will have on outcomes is vital for any subsequent analyses and translation of results back into clinical practice.
- *The EGS patient journey is complex.* Patients may be managed conservatively or operatively. They may or may not be admitted to critical care. It may be that some hospitals have NSTs and some have nutrition protocols. Different trusts will approach this in different ways and likely for different reasons. Exploring the current nature of the patient journey and these 'nutrition screening and assessment pathways' is important and may highlight potential areas to focus on in the future.
- *The EGS outcomes must be improved.* There is greater morbidity, mortality and financial cost for malnourished patients undergoing emergency general surgery, particularly an emergency laparotomy, than nourished patients. NELA 30-day mortality remains high at 8.7%. The financial burden of in-patient malnutrition was £266 million/ year almost 30 years ago; it will be higher nowadays. Performing high quality research purely on EGS patients with defined primary outcomes is vital to address these. Many of the RCTs reviewed herein did not report a primary outcome and were not reported in line with current CONSORT guidelines. Further, there was diversity of patient selection, nutritional intervention and outcomes observed making synthesis of results, and translation into clinical practice, almost impossible.
- *The EGS setting is time-limited.* Recruitment to studies is challenging as obtaining informed consent at the appropriate time in a patient's care can be difficult to navigate. Nutritional support implementation needs to be swift. Clinician decision making needs to be transparent and may be

supported using protocols. Studies may need to be multicentre and powered adequately to compensate for low rates of enrolment of eligible patients.

- *The EGS research framework needs clarity and ought to consider clinical practice.* The absence of clear definitions, gold standards and robust trials with core outcome sets is a common theme in EGS malnutrition research. This potentially hinders translation into clinical practice and improvement in clinical outcomes for patients. Guidelines from international bodies defining terms such as malnutrition and at risk of malnutrition have evolved over time and are now quite specific. However, many EGS patients are likely to be deemed only at risk of malnutrition as they will not meet the diagnostic criteria to be malnourished. Despite the abundance of screening and assessment tools, these were typically designed for a different patient population. Developing a real life understanding into the exact nature of how malnutrition in EGS is identified, and why this is the case, is paramount.



## 2 Thesis overview

This chapter outlines the research questions, hypothesis, aims and objectives of this thesis. It is a publication-format thesis, presenting five studies as discrete papers with the aim to address the gap in knowledge identified in chapter 1. A summary of each chapter in the thesis is also provided.

### 2.1 Research questions

- **Research question 1:** ‘What similarities/ difference exist in how surgeons identify malnutrition in emergency general surgery?’
- **Research question 2:** ‘If there are differences in how surgeons identify malnutrition in emergency general surgery, why do they exist?’

### 2.2 Hypothesis

- There is wide range of differences in how malnutrition in emergency general surgery is identified by surgeons, and this is multi-factorial.

### 2.3 Aim

- To examine and understand the similarities/ differences in how malnutrition is identified in emergency general surgical (EGS) patients in the UK.

### 2.4 Objectives

- **Objective 1:** To describe how malnutrition is defined in the EGS research literature.
- **Objective 2:** To describe how malnutrition is identified in current practice in NELA-eligible patients.
- **Objective 3:** To explore how consultants that undertake EGS identify malnutrition and the barriers they encounter.
- **Objective 4:** To establish how senior decision makers identify malnutrition in EGS, how they were trained and how it may be improved.
- **Objective 5:** To determine the impact of key variables on senior decision makers’ treatment preferences to start nutritional support for EGS patients.
- **Objective 6:** To understand if surgeon seniority or experience of intestinal failure influences surgeon decision making regarding starting nutritional support.

## 2.5 Thesis structure

The structure of the thesis is as follows:

- Chapter 1 outlines the background to the study, current nutritional support strategies, guidelines, important terminology and why it is an important topic to investigate.
- Chapter 2 presents the thesis hypothesis, aims and objectives.
- Chapter 3 provides an overview of the philosophical and methodological framework within which this thesis is based. An overview of methodology related to undertaking systematic reviews, surveys, qualitative studies including interviews and choice experiments are presented.
- Chapter 4 is related to research question 1 and includes two published papers:
  - *Identifying Malnutrition in EGS: A Systematic review* (Paper 1). This examines the definition of malnutrition used in EGS research, as well as the use of nutritional screening tools, assessment tools and other nutritional measures in the current literature.
  - *Malnutrition in emergency general surgery: a survey of National Emergency Laparotomy Audit Leads* (Paper 2). This is a cross-sectional survey of NELA Leads exploring current practices in identifying malnourished NELA-eligible patients, specifically focussing on screening and assessment, nutrition pathways and barriers encountered. Responses are correlated to hospital laparotomy volume to offer insight into whether this has any influence on the above.
- Chapter 5 addresses research question 2 and consists of three prepared manuscripts which have been submitted to journals for peer review:
  - *Barriers faced by surgeons in identifying and managing malnutrition in emergency general surgery: a qualitative study* (Paper 3). Through interviews, this study explores in depth how consultant surgeons identify malnutrition in EGS patients and the barriers to nutritional assessment and intervention.
  - *The influence of surgeon seniority and intestinal failure experience on identifying malnourished patients in emergency general surgery: a national survey* (Paper 4). This study characterises the awareness, practice and training of general surgeons, including consultants and non-consultants, in identifying malnutrition in EGS. Potential similarities and differences according to surgeon seniority and experience of intestinal failure are explored.
  - *What influences emergency general surgeons' treatment preferences for patients requiring nutritional support? A discrete choice experiment* (Paper 5). This study draws

on findings from previous thesis studies to inform the selection of several key factors that may influence senior decision makers to start nutritional support. By proxy, this identifies key variables surgeons use to identify malnourished patients.

- Chapter 6 summarises and triangulates study findings in relation to the thesis aims and objectives.
- Chapter 7 highlights the novelty of the thesis and impact of findings for policy makers, researchers and surgeons, as well as possible future work. The strengths and limitations of the study are discussed, and the main conclusion of the thesis presented.

## Chapter summary

- This is a publication-format thesis and is a collection of five discrete studies. Two papers have been published and three have been submitted for peer review.
- There are two research questions and six objectives.

### 3 Methodology and research paradigm

This chapter provides a description of worldviews that exist and why a pragmatic approach was adopted. The schema for this PhD is presented, as well as a discussion on mixed methods research. An overview of methodology related to each study performed in this thesis is provided. This includes methodology for systematic reviews, surveys, qualitative studies and choice experiments.

#### 3.1 Philosophical underpinning of the thesis

Informing the decision of which research design to use to answer a research question is a basic set of beliefs, research orientation or assumptions the researcher holds; a 'worldview', also called a research 'paradigm'. In planning a study, researchers are encouraged to consider and explicitly express these worldviews as they influence every stage of the study(163,164). There are many worldviews, and three of the commonest are presented in **Table 3.1**. These worldviews can be delineated through distinct components involving differences in assumptions pertaining to the ontology, epistemology, axiology and methodology of each approach(164,165).

**Table 3.1:** Summary of common worldviews ('research paradigms').

|                                                                                 | Positivism/<br>Postpositivism                                                                      | Pragmatism                                                                                                          | Social constructivism                                                                                       |
|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>Ontology</b><br>The philosophy of existence and nature of reality            | The world and reality are singular and can be understood, observed and measured.                   | A real world and multiple realities co-exist. Not committed to one philosophy. The truth is what works at the time. | The world is created through human experience, historical and cultural norms. There are multiple realities. |
| <b>Epistemology</b><br>The philosophy of knowledge and how we know what we know | Researchers test a hypothesis to determine cause and effect.                                       | A continuum of objectivity and subjectivity depending on the stage of research.                                     | Researchers interpret the views others have about the world. Researchers shape interpretations              |
|                                                                                 | Objective                                                                                          | Intersubjective                                                                                                     | Subjective                                                                                                  |
| <b>Axiology</b><br>The ethical issues and values of the research(er)            | Beneficence (research should maximise good outcomes)                                               | Value-laden (research that benefits people)                                                                         | Balanced (outcomes reflect the researcher and a balanced report)                                            |
| <b>Methodology</b><br>The process of research                                   | Experimental. Uses statistics to accept/reject hypotheses. Validity and reliability are paramount. | Uses both positivist and constructionist approaches, derives knowledge about the problem and findings solutions.    | Naturalist. Uses participant views and perspectives to generate theory.                                     |
|                                                                                 | Quantitative                                                                                       | Pluralistic                                                                                                         | Qualitative                                                                                                 |
|                                                                                 | Deductive                                                                                          | Abductive                                                                                                           | Inductive                                                                                                   |
|                                                                                 | Theory testing                                                                                     | Real-world practice orientated                                                                                      | Theory generating                                                                                           |
|                                                                                 | Generalisable                                                                                      | Transferable                                                                                                        | Contextual                                                                                                  |

Key table entries drawn from(164–166).

Positivism is associated with 'traditional science' which aims to identify a cause and effect relationship of whatever is being studied(163). A question is asked, a theory tested, and an answer obtained which can be repeated by anyone, and under the same conditions, the same results will be evident. This approach is commonly associated with quantitative studies.

Social constructivism may be considered its polar opposite. A research question, often broader and more open, leads to findings based on the interpretation of participants with many viewpoints(163). Often textual data is derived from conversation and 'stories'(166). New insights can be generated to explain how or why people experience a particular aspect of a research problem. Another researcher answering the same question and with the same data may arrive at a different interpretation of the findings. While both positivism and constructivism attempt to reduce bias, researchers inherently

affect the data collected and how it is analysed with a constructivist approach, typical of qualitative studies.

However, these worldviews are not opposite sides of a coin, rather a continuum. Along this continuum is pragmatism. It combines, integrates or 'mixes' aspects from both approaches. Morgan describes pragmatism as a new approach to methodology in social sciences, placing methodology at the centre, with three key differences to the 'duality' of positivism and constructivism(163). It uses abductive reasoning, not deductive or subjective, to connect theory and data; theories can be created and tested simultaneously. Similarly, researchers are embedded within the research process and there is a degree of intersubjectivity; they are neither purely objective nor subjective. Finally, pragmatism offers transferability of research findings, a middle-ground between wholly contextual and wholly generalisable themes associated with qualitative and quantitative approaches(167). A pragmatic approach uses different research methods to describe, understand and explore the reasons behind findings from studies in a process of triangulation(163).

This study adopts a pragmatic standpoint and is a commonly accepted approach for mixed methods research (MMR). This is sensible for two reasons. Firstly, there are various points throughout this study that will be dominated by different worldviews:

- Describing the overall issue of variation in research and current practice from an objective standpoint, using quantitative methods to perform a systematic review of the literature and a national survey of consultants.
- Exploring why these differences exist, relying on my subjective insider knowledge as part a qualitative study using interviews.
- Triangulating findings with a national survey of trainees using quantitative methods
- Investigating theory generated from the above studies in an objective approach using quantitative methods as part of a discrete choice experiment.

Secondly, in addition to the usual practice of incorporating quantitative results from investigations with qualitative aspects of a patient such as their symptoms, colleagues use different approaches to diagnose and treat patients with, on the face of it, the same clinical condition. The reasons behind this will be varied. It may result from interpretation of evidenced-based medicine or guidelines (evidential), developed through a career of surgical expertise and case history (experiential) or influenced by the environment within which we work (cultural), to name a few. As part of my clinical

role, I am already well-versed in synthesising quantitative and qualitative approaches and forming my own judgements, changing my methods depending on where I work and who I work with.

As such, a pragmatic perspective was considered the most appropriate and effective approach to adopt taking the variety of worldviews that will be encountered during this study, and my own clinical experience into account. A schematic of how the individual studies are integrated is shown (**Figure 3.1**).

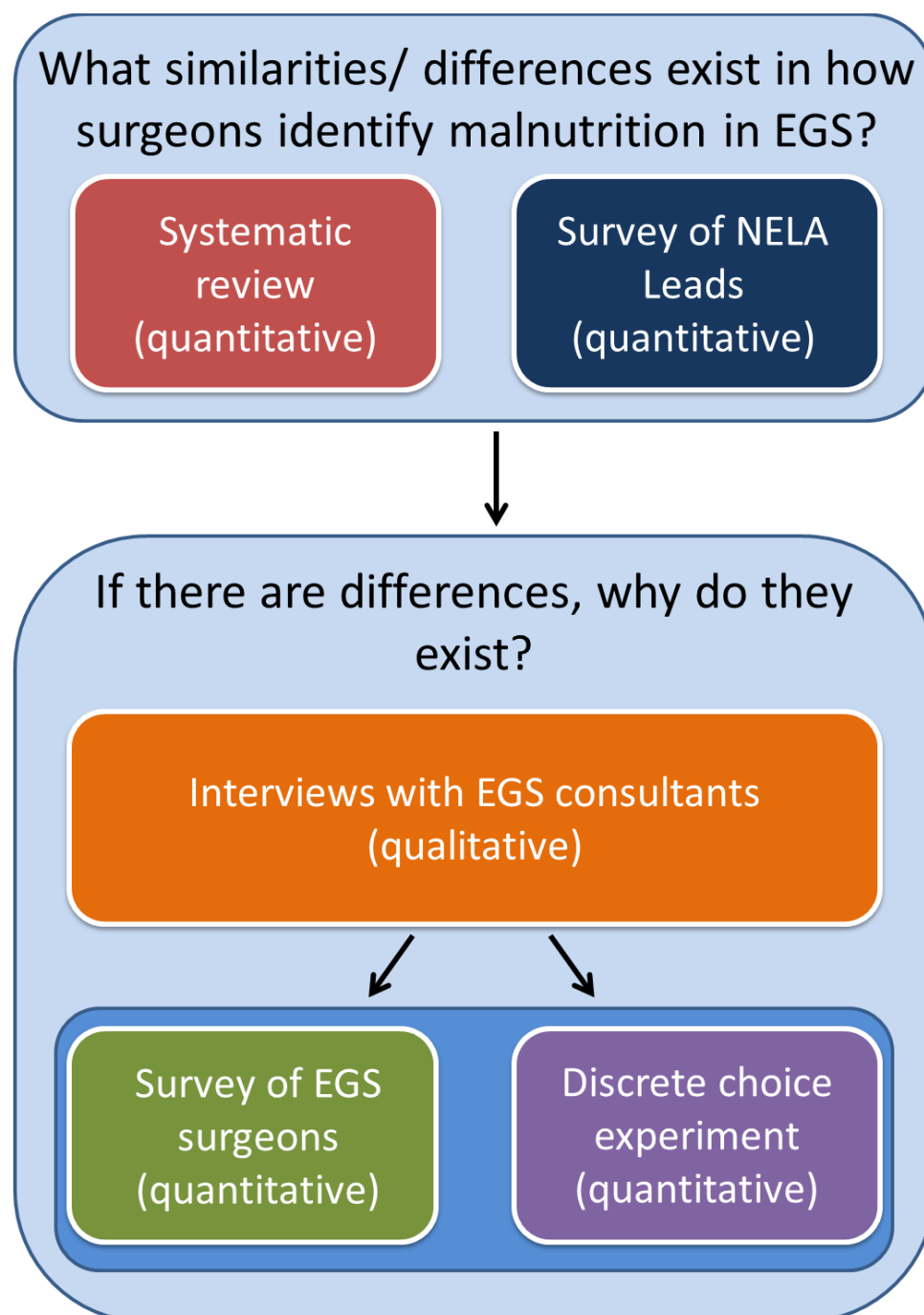


**Figure 3.1:** PhD schema

## 3.2 Mixed methods research

The definition of MMR has evolved over time(168). Essentially, it involves the collecting, analysing and integrating quantitative and qualitative data using a research design which has been framed within theory and philosophy(168). MMR has been used in surgical research and has helped inform recruitment to trials in the emergency setting(169). MMR has been recognised to benefit complex and multi-faceted research problems as found in healthcare settings(165).

MMR combines aspects of quantitative and qualitative studies (**Table 3.2**). Quantitative studies may be best at answering ‘what’ or ‘how much’ questions, and qualitative studies explore ‘why’ this might be the case. They can help confirm quantitative data or offer new insights that can subsequently be investigated by quantitative studies. In MMR, there is the opportunity to investigate a research question using multiple strategies, answering the ‘what’ and the ‘why’ questions simultaneously. With a pragmatic approach, MMR uses a ‘what works’ approach to answer research questions, filling in gaps left open by either qualitative or quantitative research alone. A cornerstone to MMR is the integration of findings from quantitative and qualitative, such that the findings are greater than the individual studies would have been by themselves. This has been described as a ‘1+1=3’ concept(170) or a ‘panoramic view’ of the research problem(171).

In summary, characteristics of MMR include(172):

1. methodological eclecticism
2. paradigm pluralism
3. an emphasis on diversity at all levels of the research enterprise
4. an emphasis on continua rather than a set of dichotomies
5. an iterative, cyclical approach to research
6. a focus on the research question (or research problem) in determining the methods employed within any given study
7. a set of basic “signature” research designs and analytical processes
8. a tendency toward balance and compromise that is implicit within the “third methodological community.”
9. a reliance on visual representations (e.g., figures, diagrams) and common notational system



**Table 3.2:** Differences in study design between quantitative, mixed methods and qualitative studies

|                          | <b>Quantitative</b>                                                                                    | <b>Mixed methods</b>                                                                 | <b>Qualitative</b>                                                                      |
|--------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| <b>Design</b>            | Confirms hypotheses<br>Experimental or non-experimental (surveys)                                      | Confirms and explores hypotheses at various points in time<br>Sequential, concurrent | Explores hypotheses<br>Narrative, phenomenological, ethnographic, grounded theory       |
| <b>Study flexibility</b> | Rigid. Questions same for all participants                                                             | Both                                                                                 | Flexible. Questions adapt depending on response                                         |
| <b>Objectives</b>        | To quantify variation<br>To predict causal relationships<br>To describe characteristics of populations | Both                                                                                 | To describe variation<br>To explain relationships<br>To describe individual experiences |
| <b>Data collection</b>   | Pre-determined, highly structured                                                                      | Both                                                                                 | Emerging, may be semi-structured                                                        |
| <b>Question format</b>   | Closed questions, instrument-based                                                                     | Both                                                                                 | Open questions                                                                          |
| <b>Type of data</b>      | Numeric                                                                                                | Multiple forms                                                                       | Non-numeric (text, images)                                                              |
| <b>Analysis</b>          | Statistical                                                                                            | Both                                                                                 | Text and image analysis                                                                 |
| <b>Interpretation</b>    | Statistical (p-values, odds ratios)                                                                    | Both                                                                                 | Themes and patterns                                                                     |

Key table entries drawn from(163,173).

A major difference in quantitative and qualitative studies is the study design and flexibility. Quantitative studies confirm, or rather aim to reject a null hypothesis. To do so mandates a rigid design whereby all participants are subjected to the same questions or conditions in order to observe quantifiable differences between groups(173). Conversely, qualitative studies explore and explain a hypothesis. This leads to a flexible study design where questions can be adapted depending on the response of the participant, and no interview will be the same. Again, MMR offers the opportunity to use the most appropriate strategy at the time to answer the research question. This can help negate the biases and limitations of one particular approach(163).

## Advantages of mixed methods research

There are several benefits to conducting MMR (**Table 3.3**)(165,168).

**Table 3.3:** Benefits to conducting MMR

| Purpose of MMR         | Explanation                                                                                                                                              | Example                                                                                                                                                         |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Triangulation</b>   | Findings from one study corroborate those from another; convergence; improves validity. The same or similar questions are asked using two methodologies. | Interviews inform how surgeons identify malnutrition, and these methods are 'tested' using a discrete choice experiment                                         |
| <b>Initiation</b>      | Findings from one study may contradict those from another and improve understanding or generate new hypotheses; divergence                               | A survey of clinicians suggests they are confident in identifying malnutrition, but interviews reveal they are not unless they have completed specific training |
| <b>Complementarity</b> | Findings from one study enhance or clarify those from another                                                                                            | Interview quotes explaining survey results                                                                                                                      |
| <b>Development</b>     | Findings from one study inform the future design of another                                                                                              | A systematic review highlights gaps in research and informs the interview schedule to fill the gaps                                                             |
| <b>Expansion</b>       | A greater breadth and range of inquiry can be achieved using multiple approaches                                                                         | A survey indicates surgeons want additional training, and focus groups reveal how this training should be designed and delivered                                |
| <b>Completeness</b>    | A combination of approaches allows for a greater understanding of the study problem                                                                      | -                                                                                                                                                               |
| <b>Offsetting</b>      | Limitations of a single approach are neutralised, and strengths combined such that more accurate interpretation of findings can be made                  | -                                                                                                                                                               |

There are disadvantages to MMR. Besides the purist view that believe in the duality of research paradigms (positivism and constructivism) and they cannot be mixed, the 'incompatibility thesis', these studies are often more complex(165,168). They require a more time to design, resources to deliver and additional training of personnel(171).

For this study, a mixed methods approach was adopted. Evidenced above, as well an absence of robust research in nutrition in emergency general surgery, there is a lack of consensus in defining, identifying and malnutrition nutrition in national and international guidelines. This gives opportunity for variation in practice and process to breed, and MMR would be ideally suited to address what the current

landscape regarding this, and start to understand why this is the case. **Figure 3.2** represents how each of the studies interlink and address the research questions.

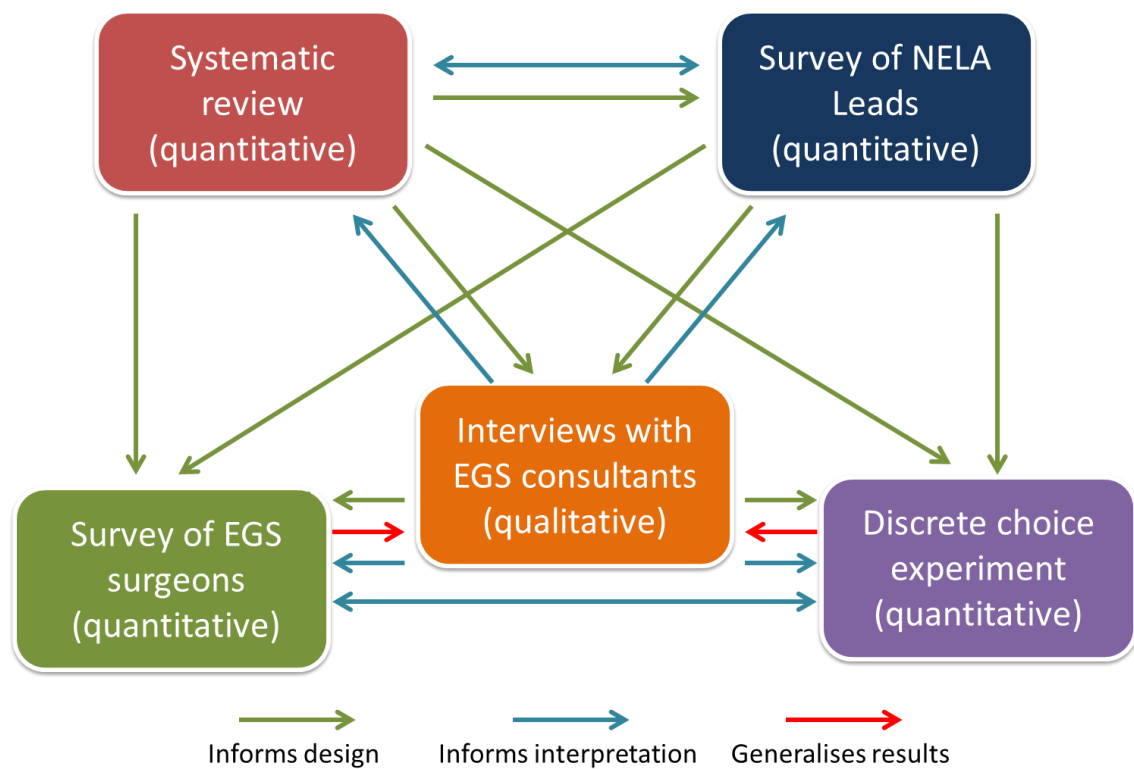


**Figure 3.2:** Relationships between studies

## Development of a mixed methods study

MMR design can be complex, and a typology-based approach is a common method to think about it. They can be fixed and pre-determined from the outset, or emergent and are developed in response to interpretation of findings or issues during the data collection. They are influenced by several factors including intent, philosophical assumptions, procedures, integration, strengths, challenges and variants(168). Four key factors to consider are:

- Timing/ sequencing of the studies relative to one another, and may be classified as 'sequential' or 'simultaneous'
- Priority/ weighting of the studies in addressing the research question, and may be classified as 'qualitatively-driven' or 'equivalent status'
- Level of interaction/ independence of the studies, and may be classified as 'component' or 'fully integrated'
- Point of interface/ interpretation of the studies. Mixing of findings from each study can occur during data collection, data analysis or during the interpretation phases.

Consequently, many typologies have been described, and they can be combined in many ways, but three core typologies are used in MMR(168). These are an explanatory sequential design, an exploratory sequential design and convergent design (**Figure 3.3**).

An explanatory sequential design aims to explain the results of a quantitative study, which is conducted first with a follow up qualitative study. Conversely, an exploratory sequential design begins with a qualitative study to explore the research question, and a follow up quantitative study helps to generalise findings to the wider population. In a convergent design, both the quantitative and qualitative studies are started simultaneously with emphasis and the results are interpreted together.

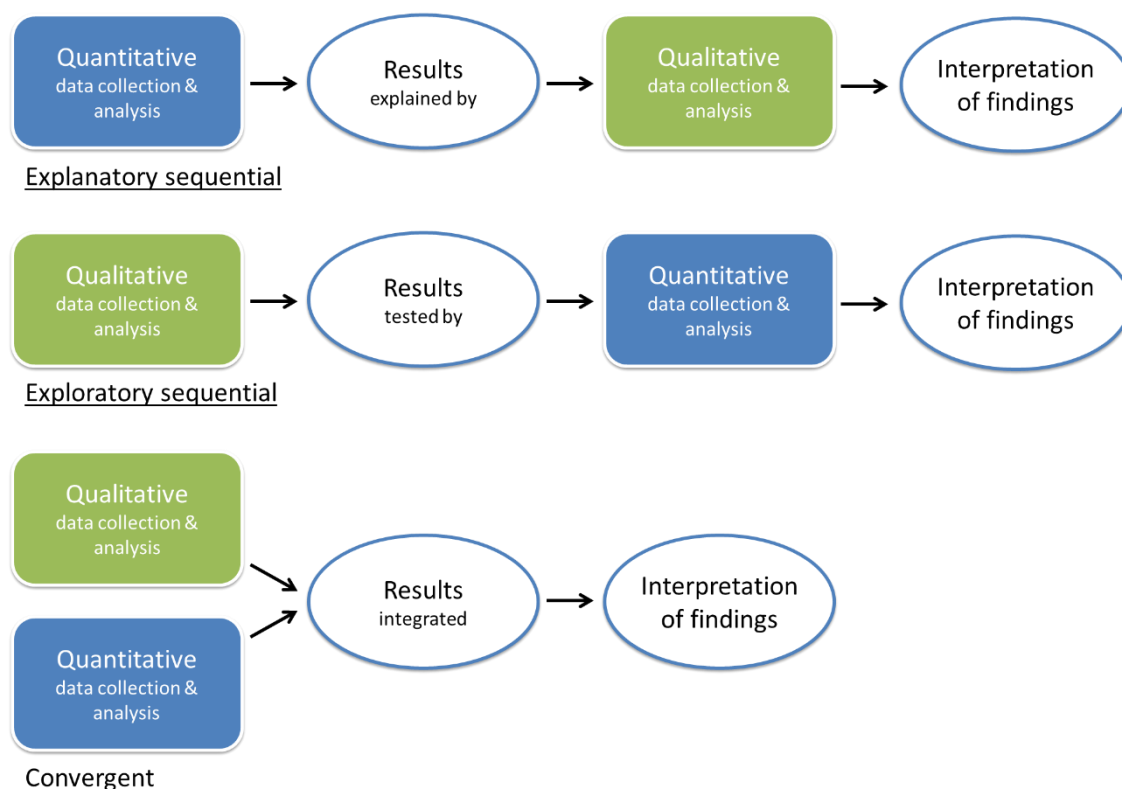


**Figure 3.3:** Core MMR designs

## Selection of a mixed methods approach

The MMR approach this study has adopted is a multi-level approach with a nested exploratory sequential study (**Figure 3.4**). The first research question, ‘What similarities/ difference exist in how surgeons identify malnutrition in emergency general surgery?’ will be addressed with a systematic review (quantitative study) and survey of NELA Leads (quantitative study). The systematic review will be started first and inform the design of NELA Lead survey. Findings from both these studies will inform the qualitative strand of the exploratory sequential study – interviews with EGS consultants – and will aim to answer the second research question, ‘If there are differences in how surgeons identify malnutrition in emergency general surgery, why do they exist?’ All three studies will then inform the quantitative stand of the nested exploratory sequential study, which consists of two simultaneous quantitative studies. These are a survey of EGS surgeons and a discrete choice experiment. All strands will then be interpreted together and have equal weighting.

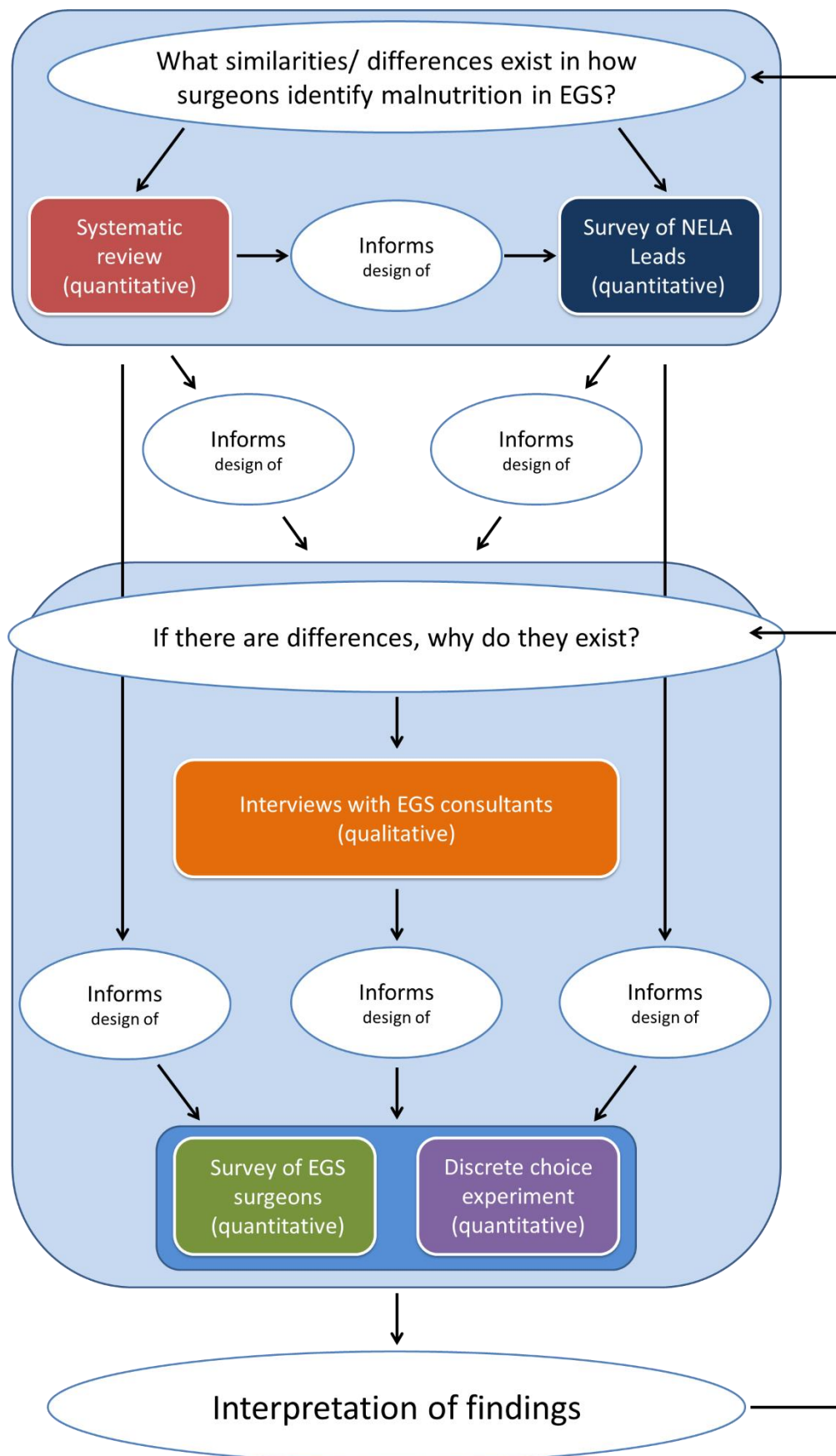


**Figure 3.4:** Overview of how each study informs one another and interpretation of findings

## Ethics and research governance

All strands within this study were conducted with appropriate research governance and having received ethical approval from the University of Sheffield. Details of this can be found at the appropriate study chapter and appendix.

## Funding

This study received no external funding. I was employed as a Clinical Research Fellow by Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust for the entire period.

## Acknowledgements

The exploratory sequential study received research support from the Association of Surgeons of Great Britain and Ireland (ASGBI) and was invaluable for participant recruitment. This is an organisation representing general surgeons across all training grades and subspecialities. It focuses on shaping future policy, facilitating the highest standards of patient care through education, and fostering a culture of innovation and research in general, emergency and trauma surgery. There was no financial remuneration. Letters of support are provided (Appendix 3).

### 3.3 Systematic review methodology

A systematic review is a research method that systematically searches for, assesses and summaries primary research studies investigating a common research question(174). The conduct of systematic reviews can be guided by the methodological handbook produced by the Cochrane Collaboration(175). They aim to be structured, transparent and reproducible. By providing a summary of the current evidence, they may indicate research knowledge gaps, prevent duplication of existing research and can inform future study design. Unique considerations to nutrition-related systematic reviews have been discussed previously(176).

There are common steps involved in performing a systematic review which are discussed(176,177).

#### **Step 1: Formulation of a research question**

The research question underpins the entire systematic review and should be feasible, interesting, novel, ethical and relevant. This must be specific and can be developed using a structured format such as the Population, Intervention, Comparator, Outcomes (PICO) framework(178). It defines the scope and study selection criteria, which should be defined *a priori* to minimise bias. It also determines which studies will be eligible for inclusion and review, and drives the statistical analysis.

#### **Step 2: Identify relevant studies**

##### **Develop a search strategy**

The search strategy should be developed, ideally with a librarian or information specialist, in order to identify all studies that match the search criteria as outlined in step 1(175). The correct Medical Subject Heading (MeSH) terms and operators must be used whilst searching multiple sources and databases. Search strategies that omit search terms will inevitably miss relevant studies. As such, caution must be maintained to ensure the study is not too restrictive (such as with study period, design or language) that important data is excluded and undermines the nature of the systematic review. This may undermine the validity of the systematic review and possibly its clinical utility as well.

##### **Registration or publication of protocol**

Whilst not absolutely necessary for publication, this step allows documentation of the methods in advance and is associated with better quality systematic reviews(179). Registering the protocol on an online registry or publishing it prior to the systematic review is aimed to minimise bias. This systematic review was prospectively registered with the PROSPERO database.



## **Study selection**

Using a reference management software, search results from multiple databases are combined and de-duplicated. Findings of a systematic review depend entirely on the data of included studies, and as such the decision of which studies to include is vital. Therefore, at least two independent reviewers screen titles and abstracts against eligibility criteria. Potentially relevant reports are 'full-text reviewed' and the same process occurs again, with the primary reason for exclusion recorded(175). Disagreements at any stage is resolved by a third reviewer. This process is recorded using a flow diagram as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines(180).

## **Data extraction**

Relevant data for each included study pertaining to aspects of its design, participants or outcomes, for example, are recorded in a structured data collection form. Errors of extraction can occur and should be minimised by this process being performed by two independent reviewers(175).

## **Step 3: Quality assessment**

The quality of studies must then be assessed in order to draw conclusions using the data extracted. The Cochrane Collaborative define bias as systematic error in the results(175). This is performed using a risk of bias assessment tool; there are different tools used for various study designs(175).

However, this systematic review did not contain any quality assessment or synthesis of data such as meta-analysis. This was not deemed necessary in keeping with other similar reviews(181). In addition:

- It would not have answered the research question of how malnutrition is identified in EGS.
- No outcome measures were extracted. Instead, it reported how malnutrition is defined and the processes used to define it within each study.
- It was expected there would be heterogeneity in study population, design, nutrition regimes implemented, and primary outcomes reported. This would have rendered any statistical analysis unhelpful. This assumption was based on the literature review within Chapter 1.4, Nutrition Therapies.

## **Step 4: Summarising the evidence**

Systematic reviews should be reported to accepted standards, such as the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines(180).

Where outcome measures have been extracted and analysed, the certainty of evidence (high, moderate, low, very low) is presented in a 'summary of findings' table. The evidence is assessed using the GRADE approach (Grading of Recommendations Assessment, Development and Evaluation) approach(175,176). For reasons outlined above, this was not necessary in this systematic review. Instead, modified and more appropriate summary of findings tables are presented.

## **Step 5: Interpretation of findings**

As with all studies, systematic reviews must communicate findings clearly to the audience for which they are intended(175). The findings of a systematic review and meta-analysis may inform clinicians to make recommendations to patients, change their practice or indeed indicate where there is a lack of data supporting either of these. Structured discussions with subheadings such as 'implications for practice' and 'implications for research' may help with this.

## 3.4 Surveys of clinical practice methodology

### What is a survey?

Surveys are ‘a systematic method for gathering information from (a sample of) entities for the purpose of constructing descriptors of the attributes of the large population of which the entities are members’(182). In essence, surveys are designed to ask questions of a representative sample (often a group of individuals) in order to learn about the characteristics of the wider population. Surveys often investigate clinicians’ knowledge, attitudes and practice and these have been used extensively in healthcare with respect to nutrition and the EGS setting(183). Data needs to be collected in a timely manner and consider the resources available. It ought to be reliable, valid and unbiased and from a representative sample(184).

### Survey design

Survey design can be considered a multi-step process (**Figure 3.5**). There are two perspectives that must be considered: the perspective of the research team in the form of minimising Total Survey Error (185) and the perspective of the responder(186). Each of the steps of survey design will be discussed in turn.

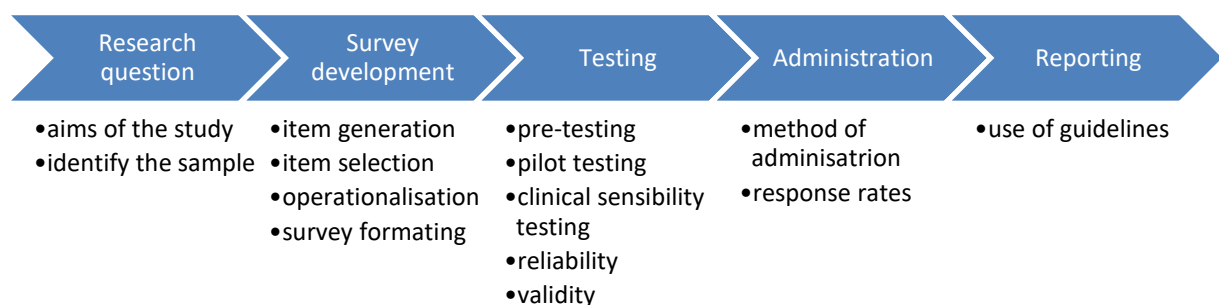


**Figure 3.5:** Survey design process

## Research question

As with any other research method, the design of the survey lies in the nature of the research question (Table 3.4)(187). The aims or objectives of the study must be clear(188).

**Table 3.4:** Types of research question for surveys

| Type               | What is it?                                           | Advantages                                                                            | Disadvantages                                                                                                                            |
|--------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Exploratory</b> | Provides a basic insight into the topic               | Convenience sample<br>Pre-test survey to aid design of future work<br>Quick and cheap | Not representative of the wider population<br>Valuable data may not be captured                                                          |
| <b>Descriptive</b> | Provides frequency data related to a topic            | Typically a random sample<br>May provide insights into wider population               | Correlation between variables does not represent causality<br>Limited understanding of why results exist                                 |
| <b>Explanatory</b> | May provide an explanation of why relationships exist | May expose causal relationships (if able to address known sources of survey bias)     | Require theoretical understanding of topic being studied<br>Operationalisation of concepts can be difficult<br>Costly and time consuming |

To ensure appropriate recruitment of participants and item generation such that the research question can be answered satisfactorily, additional consideration needs to be given to:

- Units of observations (the surveyed individuals) versus the units of planned analysis, such as aggregated observations, social interactions, or organisation level
- Experimental versus non-experimental designs
- Cross-sectional (respondents surveyed once) versus longitudinal design (respondents sampled multiple times)
- Random (probability design) versus non-random (non-probability design) sample selection

## Survey development

Survey questions need to be asked to enable the collection of data to answer the research question, but they also need to engage the participant. The process of survey development is discussed below.

## Item generation

Items are the questions or statements in a survey to which participants respond(183). Potential items can be generated by several methods including expert opinion, literature reviews, previous qualitative studies, or a combination(188). Stakeholder involvement is beneficial.

## Item selection

Investigators group items into domains of interest and select those with most relevance to the research question. This is a careful balance to not entirely remove a domain from a survey, and thus not answer part of the research question, nor keep too many and increase respondent burden(188). Surveys require a maximum of 25 questions to answer most research questions(183). Whilst this is often an iterative process with the main investigator team, it can also be informed by data from pilot testing.

## Operationalisation

This step involves the transforming the items into a question format or statement to which the participant responds(189). It is a complex process and the exact wording, framing, visual design and question order can influence a participant's response(190). In short, items are composed of stems (the question or statement) and response formats (the framework for participants' answers)(183,188).

Item stems should be short (fewer than 20 words), unbiased, non-leading and use unambiguous language, avoiding modifiers such as 'almost' and 'usually'(183). Definitive stems allow better discrimination in participant response. Where attitudes are surveyed, the perspective from which they should be answered must be stated. Questions can be open or closed. Whilst closed questions are easier to analyse, open questions can offer greater insight and depth(190).

Similarly, response formats should adhere to the above guidance. Likert responses are commonly used to elicit agreement and can be helpful in determining preferences. Although ordinal in nature, they do not imply quantity or magnitude(190). A five-point scale may be adequate(183), but a seven-point scale is more precise(184) and the use of a neutral point is debated(190). Additionally, three considerations are worth highlighting:

- Indeterminate response options: these allow participants to acknowledge uncertainty, although may reflect indecision
- Floor and ceiling effects: these reflect responses that are strongly negative or positive and provide minimal discrimination of the 'true' response

- ‘Other’ response options: these allow unanticipated answers akin to open questions, and can be helpful in study design during the piloting phase

## **Survey formatting**

In the past, postal and telephone surveys were common. Nowadays, web-based surveys whereby participants click on a hyperlink provide wider access to potential participants and benefit from being cheaper and environmentally friendly. However, similar concepts exist.

A major potential limitation is non-response and non-responder bias. Mean response rates of 35% after 12 weeks were observed in a web-based survey among surgeons, significantly lower than postal surveys(191). Maximising the response rate helps avoid this, also allowing the survey results to have greater external validity. Various methods have been shown to assist with this. These include, but are not limited to: personalisation with pre-email notifications, invitations and reminders(192); simple design; and short completion times of ten minutes or less(188). Defining terms used in the survey help(188). Progress indicators may help(188), as may financial incentives, although the evidence is mixed(192).

## **Testing**

The testing phase can be divided into pre-testing, pilot testing and clinical sensibility testing(188). Whilst there is overlap between these, there are clear differences.

### **Pre-testing**

Pre-testing involves the reviewing and revising questions to ensure questions will be interpreted correctly (the same by all respondents, and the same as the investigating team are intending) and will not unduly influence participants. This is ‘expert-driven’, which uses experts and literature, or ‘respondent-driven’, which relies on a subsample of the target population(193). Pre-testing may involve strategies to improve validity and reliability of the final survey including behaviour coding, cognitive interviews or debriefing exercises(193).

### **Pilot testing**

Pilot testing is a trial run of the study and enables investigators to ensure the necessary resources and administrative, recruitment and data analysis processes are in place(193). Others suggest it also allows another opportunity for representative participants to examine the study’s flow and administrative

ease, whilst identifying areas of redundancy, burden or misinterpreted questions(188). However, it is not able to predict response rates(193).

### **Clinical sensibility testing/ acceptability**

The final stage of survey development involves 'clinical sensibility testing' and is an opportunity to assess face validity, which is discussed further. The instrument needs to be tolerated by the sample participants(194). Considerations for this include item language, design layout, cultural context and completion time. Free text feedback or focus groups can be used to obtain this evaluation during the pilot phase. It also focusses on how well the survey addresses the study's objectives. A one-page assessment sheet can be administered to aid this stage and identify areas to redress(188).

For the findings of any survey to be helpful, surveys need to be reliable and valid. These can be tested for during pilot phase and each will be discussed in turn.

### **Reliability**

Reliability can be defined as the consistency, or reproducibility, of the instrument, and it is a precondition to validity(189). An instrument is reliable if repeat measurements under similar conditions give similar, or ideally, the same result by different researchers(183,195). A survey must enable participants who give the same answer to have intended to do so, and not because of how the question was interpreted(195). Common methods to assess for reliability are indicated(**Table 3.5**).

**Table 3.5:** Types of reliability

| Types of reliability             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Test-retest reliability</b>   | <p>The instrument is repeatedly administered to the same sample within a short period of time (typically 2-4 weeks)(188,189). This can be difficult to achieve in surveys with low responses, when domains/ practices change over time or where maintaining anonymity is paramount.</p> <p><i>Measures consistency over time.</i></p>                                                                                                                       |
| <b>Internal consistency</b>      | <p>An instrument has internal consistency if there is correlation between two questions that measure the same domain. It is usually associated with Cronbach's Alpha coefficient(189) and can be used for Likert scale questions(196).</p> <p><i>Measures consistency of individual items.</i></p>                                                                                                                                                          |
| <b>Equivalent/ parallel form</b> | <p>A method to measure internal consistency. Where there are two alternative, but equivalent, forms of the instrument (eg the same construct asked in two slightly different ways), correlation between participants that answered both forms can be measured(189). Developing alternative forms of the same question limits its use, which is mostly in a before-and-after design.</p> <p><i>Measures consistency of different versions of a test.</i></p> |
| <b>Split-half reliability</b>    | <p>A method to measure internal consistency. Items that measure the same construct are randomly divided in to two sets, and the two halves are intercorrelated(189). This useful where the instrument assesses the same construct throughout.</p> <p><i>Measures consistency of different versions of a question measuring the same construct.</i></p>                                                                                                      |
| <b>Inter-rater reliability</b>   | <p>The correlation of responses from different participants are assessed for similarity.</p> <p><i>Measures consistency of the same instrument by different participants.</i></p>                                                                                                                                                                                                                                                                           |



## Validity

Validity is the ability of the instrument to measure what was intended to be measured(189,190). There are four main types assessed or reported in survey literature (**Table 3.6**).

**Table 3.6:** Types of validity

| Types of validity         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Face validity</b>      | <p>Subjective judgements are made by participants regarding the operationalisation of the items and instrument. Questions relate to readability, consistency, relevance of questions, clarity of language used. It is the easiest form of validity to obtain but considered the weakest(189).</p> <p><i>Does the instrument appear how you would expect for this topic?</i></p>                                                                                                                                                                                                                                                                                                     |
| <b>Content validity</b>   | <p>This refers to the degree the questions in the instrument are a well-balanced sample of the content domain to be measured(189). Questions can be developed and drawn from guidelines and the existing literature, and pilot testing can highlight areas missed in the investigating team. An expert panel scores the importance of each item (not necessary, useful but not essential and essential). One statistical method to achieve this is calculating a content validity ratio, after which the lowest scored items/ items not significant at the critical level are excluded(197).</p> <p><i>Does the instrument reflect all elements of the topic being studied?</i></p> |
| <b>Criterion validity</b> | <p>The instrument has criterion validity if it compares well (has similar outcomes) to outcomes of other similar or validated instruments (a 'gold standard') of the same topic, administered at a similar time(189). There are separate components: predictive validity, concurrent validity and postdictive validity(196). These can take a longtime to complete and large sample data is required to interpret results.</p> <p><i>How well does the instrument compare to other validated instruments?</i></p>                                                                                                                                                                   |
| <b>Construct validity</b> | <p>Construct validity refers to the ability of an instrument to test the theoretical assumptions about an abstract construct such as intelligence. This is not measured in this study and not discussed further.</p> <p><i>Does the instrument compare well to theoretical assumptions?</i></p>                                                                                                                                                                                                                                                                                                                                                                                     |

The relationship between validity and reliability is demonstrated (**Figure 3.6**).

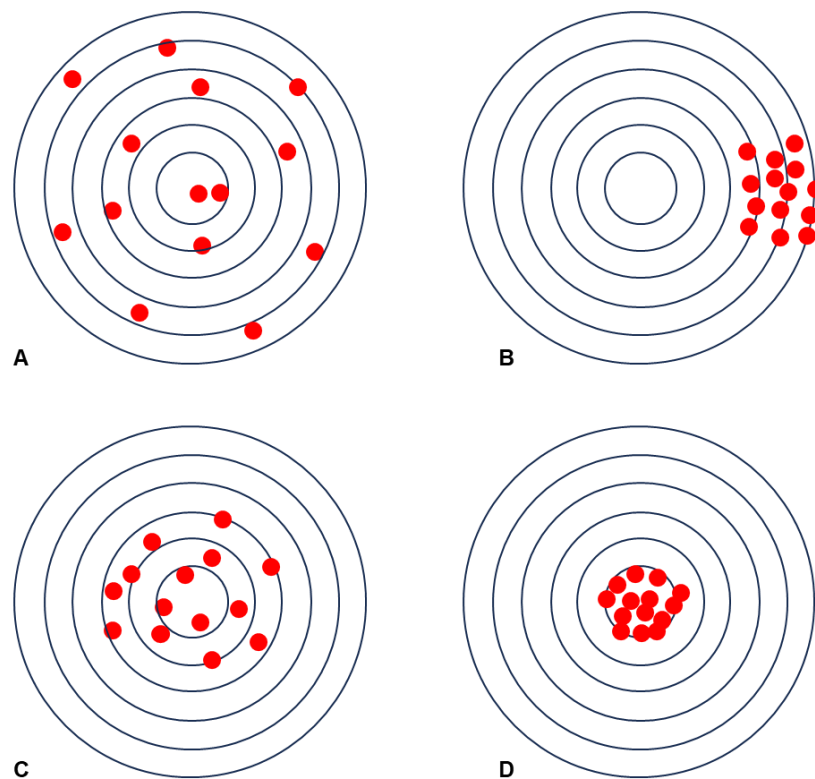


**Figure 3.6:** Relationship between reliability and validity

A = Not reliable nor valid; B = reliable, not valid; C = valid, not reliable; D = reliable and valid.

Adapted from (198).

## Administration

### Method of administration

Differences exist between various methods of survey administration, including target sample size and needs such as access to the internet, investigator time, study costs and funding available(188).

### Response rates

Greater response rates reduce selection bias and improve the validity of the study. Response rates can be increased with reminders to potential participants. Various terms for different responses rates have been reported, and this can make it difficult to understand and compare studies. This is particularly an issue with web-based surveys where there is no single response rate depending on what is chosen as the numerator or denominator(199). As such, the Checklist for Reporting Results of

Internet E-Surveys (CHERRIES) guidelines suggest reporting the view rate (ratio of unique survey visitors/unique site visitors), participation or recruitment rate (ratio of unique visitors who agreed to participate/unique first survey page visitors), or the completion rate (ratio of users who finished the survey/users who agreed to participate)(199). However, the Consensus-Based Checklist for Reporting of Survey Studies (CROSS) guidelines recommend authors providing a definition of response rate or the formula used to calculate it(200).

## Reporting

The use of guidelines improves transparency of reporting study findings and enables the readers to appraise the methodological approach to the study in a standardised way. As mentioned above, there are several guidelines available. CHERRIES is a guideline specifically for web-based surveys(199), whilst CROSS can also be used for non-web based surveys(200).

## Total Survey Error (TSE) and Total Survey Quality (TSQ)

Within all studies, in particular a complex setting such as healthcare, pragmatic decisions must be made to strike a balance between results and the limitations imposed on the study due to cost, resource and time. The accumulation of such errors, random or systematic, of survey statistics with respect to design, collection, processing and analysis of survey data are encompassed within the conceptual framework of Total Survey Error (TSE)(185,201). In addition to TSE, survey findings need to be relevant and credible; together these form the Total Survey Quality (TSQ).

Errors in surveys can be broadly classified in three groups (**Figure 3.7**): respondent selection, response accuracy and survey administration. Whilst errors can be mitigated in part by adequate sample sizes, appropriate recruitment, ensuring instrument reliability and validity in pilot testing, and careful and thorough data handling and analysis, these will still persist to some degree.

## Respondent selection

- **Sampling error:** surveying a non-representative sample of the population or through responder bias (self-selection)
- **Coverage error:** a list a sample is obtained from does not represent a target population
- **Non-response error at unit level:** sampled respondents are not contactable or refuse to complete the survey

## Response accuracy

- **Non-response at the item level:** incomplete or missing data
- **Measurement error due to respondents:** inaccurate responses such as due to not knowing the answer, misinterpreting the question or fatigue
- **Measurement error due to interviewers:** interviewers asking questions in non-standardised ways

## Survey administration

- **Post-survey error:** inaccurate processing, coding or analysis of the data
- **Mode effects:** error resulting from in how the survey was conducted
- **Comparison error:** error in comparing results from different populations or time frames

**Figure 3.7:** Sources of survey error

### 3.5 Qualitative research methodology

Qualitative research is becoming a route to investigate the complexities of a healthcare system shaped by a multifaceted interplay of individual, behavioural, social and environmental factors(202). A healthcare system with finite resources produces 'wicked problems'; issues that are unique, hard to define and understand, and difficult to solve(203,204). These are often dependent on human behaviour and relationships and cannot be easily quantified(205,206). Words and behaviours – qualitative research – can offer insight where numbers are unable to. This has been used to explore areas related to nutrition(207) and EGS(208,209) from clinicians' and patients' perspectives(208,210–212). The strategy employed depends exactly on the research question. Interviews are a commonly used data collection method to investigate nutrition in a healthcare setting, and will be discussed further(213).

#### Interview-based research

Interviews can be viewed as conversations with a purpose(214). Several aspects need to be considered with interview-based research(214,215). They are usually performed in a 1:1 format. They may use a standard set of questions (structured). They can be designed around core topics, where the sequencing of questions are participant-led but the researcher can follow up interesting strands that emerge (semi-structured). Alternatively, they can be very loosely planned and 'free-flowing' or conversational (unstructured).

Recently, face-to-face online interviews have become a medium to explore human experiences(216). They can result in wide recruitment of participants without the cost or environmental impact of travel. However, there are novel challenges beyond the usual with in-person interviews. Interviews can be performed in 'real time' (synchronous) or in a time-lapsed manner to account for time zones if international (asynchronous)(216). Participants must have access to appropriate online software. Additionally, building rapport with the participants can be difficult and online etiquette ('netiquette') can be different to in-person social interaction; there can be loss of intimacy, social cues and inaudible segments(214). Video cameras mitigates this to some extent, but data security needs to be reviewed.

This study is specifically investigating how surgeons undertaking EGS identify malnutrition, and the barriers they face in doing so. This naturally lends itself to a semi-structured interview design in order to guide the interview along these two topics, whilst also allowing for new topics to emerge. Online face-to-face interviews will be conducted to maximise geographical recruitment of participants from

multiple healthcare institutions. Participants will be audio-visually recorded using a platform with data security approved by the University of Sheffield (GoogleMeet, Google Palo Alto, CA.).

## Qualitative data analysis

Interviews are usually transcribed to produce transcripts. The data produced can be voluminous(213). These are analysed by several methods, and three were considered for this study – content analysis, grounded theory and thematic analysis – and I explain why I chose thematic analysis for this study.

1. Content analysis involves examining the frequency of content (counting words) or contextual meaning (counting and categorising words with similar meaning) of the text in order to describe and quantify themes and relationships(217,218).
2. Grounded theory uses a structured and constant, comparative coding approach to generate social theory of the problem borne from within the data(219).
3. Thematic analysis, quite simply, is ‘a method for identifying, analysing and reporting patterns (themes) within data’(220).

Some researchers do not consider thematic analysis to be a stand-alone qualitative method, although Braun and Clarke provide a thorough explanation of why it is(220). These mainly relate to the insufficient detail reported and implied poor quality of research performed compared to using other ‘named’ methods such as grounded theory. While there are many similarities in the processes such as all starting with immersion in the data, creating a coding scheme and recognising patterns, often called ‘themes’, there are key differences. In comparison to other qualitative research methods including grounded theory, it is free from any epistemological or theoretical position. Data can be analysed inductively or deductively. This allows a degree of flexibility for the researcher, making it useful to answer a wide range of research questions. Further, in contrast to content analysis, the prevalence of a code or theme across data does not imply importance. Instead, with thematic analysis, researchers can analyse data at the semantic and latent level, looking for themes derived from the words themselves (semantic themes), or beyond what is described (latent themes). This offers flexibility to the researchers to decide what constitutes a theme; the important point is to be consistent throughout the data analysis.

In the context of this strand's research question, the flexibility to be used in a variety of research paradigms, and accessibility for researchers with limited experience of qualitative research, thematic analysis was chosen as the qualitative method for this study. Despite already having some tacit knowledge of the potential issues that may arise having already undertaken a literature review, a systematic review, a national survey of NELA Leads, and inevitably from my clinical role as a general surgeon, I will use an inductive approach to analyse the data. Codes and themes will not be created *a priori*. This also matches the pragmatic worldview with which this study has been approached from the outset.

## Framework method

One type of thematic analysis is the Framework Method, and it is frequently used in healthcare research with semi-structured interviews(221). It was originally developed for policy research by researchers from the Qualitative Research Unit at the National Centre for Social Research(222). It is a dynamic, highly structured approach with the generation of a coding matrix with cases (rows) versus codes (columns) and the cells representing the source data itself. This allows researchers to analyse data according to themes (what was said) and cases (who said what). Cases are study participants or pre-defined groups or organisations. It allows a comparative thematic analysis using both deductively- and inductively-derived themes(223). This was considered especially useful in this study where data across three organisations (district general hospitals, teaching hospitals, intestinal failure units) could be compared. As such, the Framework Method was considered an appropriate qualitative analysis method for this study.

There are five steps in the analysis of data with the Framework Method(223,224).

### Step 1: Familiarisation with the data

This stage involves listening to the audio recordings, transcribing the interviews and reading the transcriptions. Observational notes, 'field notes', made during the interview can also be reviewed at the same time. Where datasets are large this could also be done using a purposeful sampling method to ensure immersion in the richest data set. Broad brush stroke ideas or themes may present themselves and begin the process of abstraction and conceptualisation.

## **Step 2: Identifying a thematic framework**

Step two extends this abstraction and conceptualisation of the data. It is usually developed using coding of text by two routes. Firstly, *a priori* issues, which are categories that may be expected from previous literature and guide subsequent interview questions, are identified. These are combined with emergent concepts and themes, which are issues raised by the participants during the interview. This forms a 'framework' and allows for codes, themes and subthemes to be ordered, refined and combined in a way that aims to ensure the research question is addressed. Independent analysis by another member of the study team may lead to the generation of a different framework, and will reflect the different viewpoints each researcher brings to the study. This emphasises the need for reflexivity throughout the process. Corroboration of these frameworks into a single framework which can be applied to the rest of the data is performed.

## **Step 3: Indexing/ coding**

The framework is then applied to the entire data set in an iterative systematic manner, line-by-line(223). Text is coded by highlighting phrases or words that may be pertinent to the research question, and 'paraphrasing' the meaning of the text. This creates an 'audit trail' and improves the trustworthiness of the process. As new codes are generated and more themes emerge, the framework can be amended as necessary. Inferences, judgements and decisions are needed to simplify the codes such that there is no overlap and redundancy, but which captures all the relevant data. Again, coding can occur by individual researchers to improve trustworthiness of the process.

## **Step 4: Charting**

A chart, or matrix, is generated to order and abstract the data, allowing the entire dataset to be examined from an aerial perspective. Again, at this stage, codes, the hierarchy of codes, themes, subthemes, as well as the framework itself, can be adapted at this stage. This ensures the data captures the essence of the participant's interviews whilst addressing the research question. It was anticipated to chart at a participant and organisational-level (district general hospital, teaching hospital and specialist IF centre) primarily, whilst indexing/ coding (step 3) occurred at a participant level only. NVivo is a computer-assisted qualitative data analysis software (CAQDAS) program which has the functionality to perform this step and retain live links between the raw data and the chart(223). For this reason, it will be used in this study.



## Step 5: Mapping and interpretation

In the final stage, the researcher attempts to provide summarise all the elements of the process together, looking for concepts, patterns and explanations within and across cases and codes at participant and stakeholder/ organisational-level. This is presented as a narrative, a typology, or a conceptual map showing relationships between identified themes.

## Strengths and limitations of the Framework Method

Beyond being a pragmatic method with the ability for an inductive or deductive approach, the main strength in the Framework Method lies the generation of the matrix. This allows inferences to be made across different stakeholder groups, rather than generating a simple list of themes. A richer narrative can be generated. Additionally, each step is explicit, auditable, and transparent.

Each step is a time-consuming process and can generate masses of data. Transcribing, indexing and charting a one-hour interview may take most of a day for novices and produce 30 pages of text. Additionally, whilst this process can be broken down into steps, the method is not a recipe, and interpretation of data and concepts, and modification of the framework, is required throughout. Generating a matrix can also lead to a reductive and quantitative approach of x number of participants identified by y theme. This will be meaningless and should be avoided(221).

## Rigour in qualitative research

Trustworthiness is a key concept in qualitative research which is inductive in nature and not associated with p values and confidence intervals as quantitative research is. There are four important considerations to ensure quality in qualitative research (**Table 3.7**)(225,226).

- **Credibility:** this describes whether readers recognise the experiences described by the researcher from the data and whether they would come to the same conclusions; how plausible the findings are. It can be accounted for by triangulation, member checks and peer debriefing.
- **Transferability:** the ability to generalise the findings between different contexts because of similarities between them based on 'thick descriptions' of each. It can be accounted for by purposive sampling and generating thick descriptions of contexts being compared.
- **Dependability:** relates to the degree of stability or variance that can be ascribed to sources. This can be accounted by using methods that are logical, traceable and clearly documented (auditable).

- **Confirmability:** this describes the extent in which the findings are derived from the data and 'researcher-free'. It can be accounted for by describing processes for theoretical, methodological and analytics choices throughout the study so others can understand how and why decisions were made, as well as triangulation to reduce researcher bias and practicing reflexivity.

**Table 3.7:** Terms for trustworthiness

| Aspect        | Qualitative term | Quantitative term akin to |
|---------------|------------------|---------------------------|
| Truth value   | Credibility      | Internal validity         |
| Applicability | Transferability  | External validity         |
| Consistency   | Dependability    | Reliability               |
| Neutrality    | Confirmability   | Objectivity               |

Several tools are available to assist researchers to maintain and readers to evaluate trustworthiness of a qualitative study(220,227–230). This study is discussed with reference to one of these to highlight how quality has been maintained within this study (**Table 3.8**)(227).

**Table 3.8:** Study quality against the Quality Framework Assessment

|                        | <b>Appraisal question</b>                                           | <b>How addressed in this study</b>                                                                                                                                                                                                                                                                                    |
|------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Findings</b>        | How credible are the findings?                                      | Corroborating evidence has been used to support findings from other strands within this mixed methods research (chapter 6).                                                                                                                                                                                           |
|                        | How has knowledge/ understanding been extended by the research?     | A literature review of current nutritional support and a systematic review of methods to identify malnutrition has been performed.<br>Findings are discussed in the context of what is previously known and policy implications discussed.<br>Limitations of evidence discussed in each strand chapter and chapter 7. |
|                        | How well does the evaluation address its original aims and purpose? | Aims and objective for each strand of the study presented.<br>Summary of findings and study limitations provided (chapters 6 and 7).                                                                                                                                                                                  |
|                        | Scope for drawing wider inference – how well is this explained?     | MMR design allows external validity of findings with quantitative studies.<br>Context of UK-based studies explained throughout. Purposive sampling in qualitative study increased transferability.                                                                                                                    |
|                        | How clear is the basis of evaluative appraisal?                     | N/A                                                                                                                                                                                                                                                                                                                   |
| <b>Design</b>          | How defensible is the research design?                              | Research strategy and design discussed in chapter 3 and 5.                                                                                                                                                                                                                                                            |
| <b>Sample</b>          | How well defended is the sample design?                             | Purposive sample design for qualitative study explained in chapter 5, and data saturation discussed.                                                                                                                                                                                                                  |
|                        | Sample composition – how well is the eventual coverage described?   | Participant recruitment strategy and composition with respect to hospital type, sex and IF experience for study 3 are explained in chapter 5.                                                                                                                                                                         |
| <b>Data collection</b> | How well was the data collection carried out?                       | Data collection details can be found in chapter 5.<br>Audio-visual recordings of interviews produced verbatim transcripts. All transcription                                                                                                                                                                          |

|                                   |                                                                                                                                |                                                                                                                                                       |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                   |                                                                                                                                | performed by researcher to maximise immersion in data.                                                                                                |
| <b>Analysis</b>                   | How well has the approach to and formulation of the analysis been conveyed?                                                    | NVivo software used and development of themes and typologies described in appendix 3.                                                                 |
|                                   | Contexts of data sources – how well are they retained and portrayed?                                                           | Framework Method used to retain context with electronic linkage and audit trail back to raw data.                                                     |
|                                   | How well has diversity of perspective and content been explored?                                                               | Purposive sampling to ensure recruitment for sex maintaining diversity perspective.                                                                   |
|                                   | How well has detail, depth and complexity (i.e. richness) of the data been conveyed?                                           | Illuminating textual extracts used showing richness of data.                                                                                          |
| <b>Reporting</b>                  | How clear are the links between data, interpretation and conclusions – i.e. how well can the route to any conclusions be seen? | Findings and interpretations reported alongside illustrative original data                                                                            |
|                                   | How clear and coherent is the reporting?                                                                                       | Findings reported in line with COREQ guidelines for qualitative studies highlighting thematic linkages and typology.                                  |
| <b>Reflexivity and neutrality</b> | How clear are the assumptions/theoretical perspectives/values that have shaped the form and output of the evaluation?          | Assumptions underpinning study discussed in appendix 3. Reflexivity and impact of researcher influence discussed in chapter 3.                        |
| <b>Ethics</b>                     | What evidence is there of attention to ethical issues?                                                                         | University of Sheffield ethical approval obtained. Confidentiality and anonymity discussed with all participants. Written, informed consent obtained. |
| <b>Auditability</b>               | How adequately has the research process been documented?                                                                       | Summary findings, strengths and limitations of study discussed in chapters 6 and 7. Main study documents reproduced (appendix 3).                     |

Framework template based on (227).

## 3.6 Discrete choice experiments methodology

### Types of choice experiments

A range of stated preference methods are available to understand decision making. In healthcare, the following methods have all been used: discrete choice experiments (DCE)(231–234), conjoint analysis(235), and judgement analysis(236,237). They all assess preferences for a choice at an individual level based on assumptions that these choices can be described by a number of variables. Thus, they can be used to estimate the trade-off an individual is willing to make when assessing several variables together. However, there are some key differences. A comparison of these methods is provided (**Table 3.9**).

**Table 3.9:** Types of choice experiment

|                                    | <b>Discrete choice<br/>experiment</b>                                             | <b>Conjoint analysis</b>                                                                                              | <b>Judgement analysis</b>                                                        |
|------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| <b>Origin(238,239)</b>             | Based on random utility theory and can provide an explanation of choice behaviour | Evolved from conjoint measurement and is purely mathematical, not concerned with choice behaviour                     | Uses the Lens Model based on Social Judgement Theory to explain choice behaviour |
| <b>Choice making</b>               | Participants choose between alternatives                                          | Participants rate (1-5) or rank-order choices                                                                         | Participants choose between alternatives                                         |
| <b>How variables are presented</b> | A single list of variables<br>Clinical context often minimal                      | ≥2 'choice sets' containing a list of variables<br>Clinical context often minimal                                     | Values are often placed within a case vignette representing a clinical scenario  |
| <b>Scenarios</b>                   | Hypothetical                                                                      | Hypothetical                                                                                                          | Hypothetical or real                                                             |
| <b>Advantages</b>                  | Choosing between options more closely resembles clinical practice                 | Trade-offs between competing variables can be assessed simultaneously                                                 | Data regularly presented to clinicians like this<br>Very engaging                |
| <b>Disadvantages</b>               | Less engaging<br>Participants may choose same choice to quickly complete study    | Limited resemblance of clinical practice as not all options available to patients and so ranking options not possible | Designing realistic cases is difficult<br>Time consuming to complete study       |

A DCE design was chosen for the following reasons:

- This method has been used in healthcare previously including in relation to prostate cancer(231), breast cancer(232), major gastrointestinal surgery(233), and from a nutrition perspective(234)
- It more closely resembles the actual clinical environment where choices are required to be made(240,241).
- Avoids the complexity of designing case vignettes, balancing the experimental rigour whilst capturing clinical reality, as well as the additional researcher resource developing these and participant burden completing the study(242). This must be counterbalanced against

introducing hypothetical bias, the extent to which preferences are able to predict real-world choices(243).

- DCEs have been shown to have predictive ability (external validity) when assessing the revealed and stated preference of participants of healthcare-related studies(244). In other words, the responses participants choose in a DCE reflect their real-world decisions.

## What is a discrete choice experiment?

A Discrete Choice Experiment (DCE) is a type of stated-preference method derived from health economics(188,189). It is a quantitative technique using a survey approach to elicit the preferences of stakeholders of a wide range of hypothetical scenarios, goods or services, or in this study, a patient(190). In the healthcare setting, they are typically used to understand decision making regarding treatment choices. The scenarios are presented to healthcare professionals, outcomes of two or more treatment options are balanced and a choice made based on the merits of each option. Based on Random Utility theory, it suggests participants choose the option from the scenario which gives them most 'utility' or satisfaction(238,245). This method has been used previously in a range of studies including patient preferences in prostate cancer(194), clinician preferences in breast cancer(195), meal choices, nutrition content and behaviour(196), but has not been used in the context of EGS.

It is assumed that participants choose the alternative that yields the best outcome, and that these depend on the composing variables and levels(241). As such, this DCE will provide data on the relative weight or value surgeons attach to the individual variables in deciding whether to start nutritional support for a patient. This will assist in quantifying key determinants that were elicited from previous studies as part of this MMR study, and may help inform future policy changes.

## Designing a DCE study

There are five steps to designing and conducting a DCE(191).

### Step 1: Identifying the attributes

Variables, called 'attributes' in DCEs, describe the characteristics of the patient upon which an individual's treatment preference depends(192). An assumption exists that the chosen variables provide enough information for participants to adequately make a choice. Consequently, the validity of the DCE depends on correctly identifying the relevant variables. There is no defined method to identify which variables to include or the value to place on them, although qualitative research is recommended(238,246). Published literature and expert reviews also assist with this. While no restrictions in number of variables to include exist, to ensure participants can consider all of them in the decision making, DCEs typically range from 3-16(241); most use six(247). This is beneficial for two reasons. Firstly, variables need to be mutually exclusive to avoid inter-attribute correlation. Any overlap in variables would prevent discerning the effect a single variable has on the decision making process. Secondly, increasing choice set complexity may lead to participants developing 'satisficing' decision rules whereby only a subset of the provided information is used when making a choice(248).

In this study, six variables were derived from relevant literature(50), each of the previous studies within this MMR including qualitative interview data, and informed by guidelines.

### Step 2: Assign levels to the attributes

The next step is to assign plausible 'levels' to the chosen attributes. Levels are akin to clinical severity, and variables should have two or more levels. For example, if age is an attribute to be used in the DCE, older patients may be assigned a higher level given that they generally have a lower physiological reserve, more co-morbidities and a greater risk of worse outcome such as post-operative complication or death. There is variance in the literature regarding how many variables are acceptable and how to assign their levels(193). But it is important to consider how the level is presented to participants and for continuous variables, researchers must specify levels to apply to the design(249,250). In the above example, age could be presented as 'young' or 'old', but this forces participants to make judgements about what constitutes young or old; a value ( $<70$  and  $\geq 70$ ) or a range (51-60, 61-70, 71-80 and so on) is better. As with variable selection, levels should be realistic, meaningful and mutually exclusive in order for the analysis to be accurate(241).



### **Step 3: Generating scenarios and questionnaire**

Choice sets, which are scenarios developed using the chosen variables and levels, are generated by combining hypothetical alternatives. A full factorial design of three variables each with five levels would produce 243 possible alternatives ( $3^5$ ). Clearly this would be too many scenarios for participants to answer, and so a fractional factorial design is used, where only a selection of the possible alternatives are used(241). Two further important considerations include:

- Orthogonality: each set of levels appear with the same frequency across each pair of attributes, meaning the variables are considered statistically independent(251,252).
- Balance: each variable appears with the same frequency with minimal overlap(253,254).

Plausible scenarios are selected to ensure the variables within it are clinically realistic. In this DCE, all variables and levels could be associated with each other, and so all scenarios were plausible. Typically 18 scenarios are chosen for the DCE, but this ultimately is a balance between the number of variables and levels chosen(251). DCEs in healthcare usually present two options for participants to choose between in a forced choice pair-wise design(233). Occasionally a third alternative, often an 'opt out' option presented as 'prefer not to say' or 'prefers neither', can help in DCEs where both choices are valid and can add realism(255), but do not assist in the analysis of trade-offs required as part of the decision making process(241).

### **Step 4: Data collection**

Step 4 establishes the preferences of the chosen population. DCEs are distributed using survey methodology, which was discussed in chapter 3. This includes a clear presentation and introduction to the choice set examples for self-administered DCEs(241). It should be piloted to check for face validity. One or two additional scenarios with superior levels for all variables and 'an obvious choice' for participants to make can help to assess for internal consistency, but this is not necessary.

This DCE (study 5) was combined with 'How do we identify malnutrition in EGS? A national survey of current practice' (study 4) and so participant burden was of particular concern in the design process.

### **Step 5: Analysing the data**

The approach to data analysis depends on the design of the DCE. In pair-wise designs, a binominal regression model is used to identify associations between the

treatment preference and the variables given in the scenarios. The regression coefficients (odds ratios) are calculated for each unit of change in the corresponding variable against the reference level for each variable. The reference levels were decided pre-administration of the DCE. The cluster option will be used to calculate confidence intervals and p-values. This is because outcomes were clustered by participant and takes into account the lack of response independence as each participant will answer all the scenarios.

## Chapter summary

- This thesis adopted a pragmatic perspective.
- A mixed methods approach was used, combining four quantitative and one qualitative study into a multi-level approach with a nested exploratory sequential study.
- Studies 3-5 received research support from the Association of Surgeons of Great Britain and Ireland (ASGBI).
- An overview of methodology for systematic reviews, surveys, qualitative research focussing on thematic analysis and choice studies is provided.
- Additional methods for each paper are provided in appendices:
  - Paper 1: systematic review (appendix 1)
  - Paper 2: survey (appendix 2)
  - Paper 3: qualitative study (appendix 3)
  - Paper 4: survey (appendix 4)
  - Paper 5: discrete choice experiment (appendix 5)

## 4 Research question 1: What similarities/ differences exist in how surgeons identify malnutrition in emergency general surgery?

This chapter presents two papers which aim to answer this research question.

Paper 1 is a systematic review of observational studies and examines the current methods of defining malnutrition in emergency general surgery.

Paper 2 is a cross-sectional survey of surgical and anaesthetic National Emergency Laparotomy Leads. It describes current practices in identifying malnutrition, specifically focussing on screening, assessment, nutrition pathways and barriers encountered by clinicians.

Objectives addressed in this chapter are:

- **Objective 1:** To describe how malnutrition is defined in the EGS research literature.
- **Objective 2:** To describe how malnutrition is identified in current practice in NELA-eligible patients.

## 4.1 Identifying Malnutrition in EGS: A Systematic review (Paper 1)

### Chapter introduction

The systematic review presented here is based on the manuscript published in the British Journal of Surgery Open following peer review and is reproduced under an open access Creative Commons Attribution (CC BY) license. Under this license, the content of the article can be reused by anyone, for any reason, as long as the author and original source are properly cited.

**Ashmore DL**, Rashid A, Wilson TR, Halliday V, Lee MJ. Identifying malnutrition in emergency general surgery: systematic review. BJS Open. 2023 Sep 25;7(5):zrad086.

### Author Contributions

**Daniel L. Ashmore:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Writing—original draft, Writing—review & editing

**Adil Rashid:** Data curation, Methodology, Validation, Writing—review & editing

**Timothy R. Wilson:** Methodology, Supervision, Writing—review & editing

**Vanessa Halliday:** Conceptualization, Methodology, Supervision, Writing—review & editing

**Matthew J. Lee:** Conceptualization, Methodology, Supervision, Writing—review & editing

### Supporting appendices

#### Appendix 1

- Additional files to support Paper 1
  - **Additional File 1:** Example search strategy for Medline
- Supplementary tables for Paper 1
  - **Table S1:** Summary characteristics of each included study
  - **Table S2:** A summary of single centre prospective studies
  - **Table S3:** A summary of multicentre prospective studies
  - **Table S4:** A summary of single centre retrospective studies
  - **Table S5:** A summary of multicentre retrospective studies
  - **Table S6:** A summary of a single centre study (not stated if retrospective or prospective)
  - **Table S7:** Criteria used in defining malnutrition according to ‘core areas’

## Abstract

### Background

Emergency general surgery practice is high risk. Surgery is a key part of treatment, with resultant catabolic stress and frequent need for nutritional support. The aim of this study was to examine the current methods of defining and determining malnutrition in emergency general surgery. This included examining the use of nutrition screening and assessment tools and other measures of malnutrition.

### Method

MEDLINE, Embase, Cumulative Index to Nursing and Allied Health Literature, trial registries, and relevant journals published between January 2000 and January 2022 were searched for studies of adult patients with any emergency general surgery diagnosis, managed conservatively or operatively, with an assessment of nutritional status. Mixed populations were included if more than 50% of patients were emergency general surgery patients or emergency general surgery results could be separately extracted. Studies in which patients had received nutritional support were excluded. The protocol was registered with PROSPERO, the international prospective register of systematic reviews (CRD42021285897).

### Results

From 6700 studies screened, 324 full texts were retrieved and 31 were included in the analysis. A definition of malnutrition was provided in 23 studies (75%), with nutritional status being determined by a variety of methods. A total of seven nutrition screening tools and a total of nine 'assessment' tools were reported. To define malnutrition, the most commonly used primary or secondary marker of nutritional status was BMI, followed by albumin level.

### Conclusion

Wide variation exists in approaches to identify malnutrition risk in emergency general surgery patients, using a range of tools and nutrition markers. Future studies should seek to standardize nutrition screening and assessment in the emergency general surgery setting as two discrete processes. This will permit better understanding of malnutrition risk in surgical patients.

## Introduction

Emergency general surgery (EGS) is the single largest group of surgical patients admitted to hospital in the United Kingdom (UK)(3). EGS represents 4.2% of all hospital admissions in the UK, and 7.1% in the United States(4). More than a quarter of patients admitted in this setting require surgery(4,5), which carries a high risk of morbidity and mortality(6–8). Malnutrition is an established risk factor for worse outcomes including more frequent nosocomial infections(51), extended length of stay(7), increased mortality(8) and increased healthcare service costs(7,52,53).

Despite the size of this challenge, there is no universally accepted definition for malnutrition in the literature, or in EGS clinical guidelines(68,98,101–103,106,107). The current incidence of malnutrition in EGS patients has not been clearly established, but may be as high as 40-60%(8,48). Knowing which patients are malnourished will allow targeted nutritional support which may improve outcomes.

The identification of malnourished patients is typically a two-step process(54,55). This involves initial screening, followed by a more comprehensive assessment by an appropriate healthcare professional for those deemed to be at risk. There are an abundance of methods and tools to determine the risk of malnutrition in patients, though very few are validated in the EGS cohort. There is no international consensus on which screening tool should be used(98,106,109).

The Malnutrition Universal Screening Tool (MUST) is one such screening tool that has been validated across multiple healthcare settings and populations. It was developed from a community tool by the Malnutrition Advisory Group of the British Association for Parenteral and Enteral Nutrition (BAPEN)(75,256) and consists of three domains (body mass index, unintentional weight loss and acute disease or lack of nutrition affect. A score of two or more out of six indicates high risk of malnutrition and the need for specialist dietetic involvement. It is widely implemented across UK settings(257,258) and is used as a screening tool in the majority of UK health institutions as their standard screening tool.

## Aims

The aim of this study was to perform a systematic review of observational studies to describe how malnutrition is identified in EGS. It focussed on nutrition screening and assessment tools, their components, as well as other markers of malnutrition.

## Methods

### Protocol and registration

The systematic review was performed with reference to the Cochrane Handbook, and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines(180). The protocol was registered with PROSPERO (CRD42021285897).

### Eligibility criteria

Studies of adult (aged  $\geq 18$  years) patients with any EGS diagnosis, managed conservatively or operatively were included (**Table 4.1**). Participants must have had their nutrition status determined at some point in their hospital stay using a screening tool, assessment tool or other measure of malnutrition. Studies on mixed patient populations (mixed surgical specialty, emergency and elective general surgical, or surgical and medical) were included if the EGS and non-EGS results were reported separately or if more than the 50% of the population reported are EGS patients. The same applied to studies of EGS and trauma patients. Studies where a nutritional intervention at any stage (oral, enteral or parenteral) was described in the population were excluded as observational studies were considered more likely to reflect real world practice. Additional exclusions applied to studies of pregnant women, eating disorders, inappropriate study design (letters to the editor), review articles and abstracts with no corresponding full text. Whilst studies published from any country were considered, non-English texts were excluded as no resource was available to secure accurate and reliable translations.

**Table 4.1:** Inclusion/ exclusion criteria

| Included                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Excluded                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Adults (aged 18 years and over)</li> <li>• Emergency general surgery (EGS) patients</li> <li>• Any general surgical disease or operation</li> <li>• Patients were managed conservatively or operatively</li> <li>• Must have included an assessment of nutritional status (using a screening tool, assessment tool or other measure)</li> <li>• Published year Jan 2000 – Jan 2022</li> <li>• Any gender</li> <li>• No geographical or healthcare facility restrictions</li> </ul> | <ul style="list-style-type: none"> <li>• Non-general surgery patients</li> <li>• Non-emergency patients (including studies of cancer resections where it was not clearly stated this was performed as an emergency)</li> <li>• No assessment of nutritional status (using a nutritional screening tool, assessment tool or other measure)</li> <li>• Mixed study: Studies on non-emergency patients (studies were included if the EGS and non-EGS results were reported separately or if <math>\geq 50\%</math> of the population reported were EGS patients)</li> <li>• Trauma study: (studies were included if trauma and non-trauma results were reported separately or if <math>\geq 50\%</math> of the population reported were EGS patients)</li> <li>• Patients received a nutritional intervention (including oral supplements, enteral and parenteral nutrition) at any stage (eg an RCT)</li> <li>• Non-full texts eg conference abstract only with no supporting full text</li> <li>• Inappropriate study design (editorials)</li> <li>• Reviews of the literature</li> <li>• Non-English texts</li> <li>• Pregnant women</li> <li>• Eating disorders</li> </ul> |

Abbreviations: emergency general surgery (EGS); randomised controlled trial (RCT); United Kingdom (UK).



## **Definitions**

### **Nutrition screening tool**

This was defined as a tool to identify individuals at risk of malnutrition. Although this would ordinarily subsequently lead to a full nutritional assessment by a dietitian, this was not necessary to be included in the review.

### **Nutrition assessment tool**

Due to a lack of clear terminology in the literature, in this review we defined a nutrition assessment tool as a method that either:

- Characterised the nutritional status of an individual to confirm whether they are malnourished and/or to what degree; or,
- Had 'assessment' in the name of the tool and was referred to by that throughout the study; or,
- Was used when the authors considered that a nutritional assessment (rather than screening) had taken place.

## **Outcomes**

The primary outcome of this review was to identify which nutrition screening or assessment tools are used in the EGS population, and what their component parts are.

Secondary outcomes included mapping the range of alternative criteria used in defining malnutrition in EGS. This was purposefully kept broad to allow a full overview of the range of methods currently used to assess nutritional status. It included anthropometric indices (for example height, weight, body mass index (BMI), skin fold thickness), biochemical markers (for example albumin, lymphocyte count) and others (for example wound healing, functional recovery). This would help understand the range of definitions used for malnutrition in EGS research.

## **Search Strategy**

A systematic search for studies from January 2000 to January 2022 was performed within the following databases: MEDLINE (via Ovid SP), Embase (via Ovid SP), CINAHL (via EBSCO) and Cochrane CENTRAL. An example search strategy is provided in Appendix 1. In addition, the following clinical trial registries were also searched: ClinicalTrials.gov, WHO International Clinical Trials Registry Platform and the EU Clinical Trials Register. Reference lists of eligible studies were checked, as were reports published by

the relevant organisational bodies, including the Department of Health UK, the National Institute for Health and Care Excellence (NICE), the Royal College of Surgeons and the British Society of Parenteral and Enteral Nutrition. Selected journals were searched, including Clinical Nutrition, the Journal of Parenteral and Enteral Nutrition, the Journal of Human Nutrition and Dietetics, Nutrition and Dietetics, and Nutrition BMC Springer.

## **Study selection and screening**

Titles and abstracts were screened for eligibility by two independent reviewers (DA and AR) using Rayyan Systems Inc.(259). Manuscripts meeting eligibility, or where there was insufficient detail to make an assessment of eligibility, were obtained for full text review. Disagreements, where necessary, were settled with a third reviewer (ML). All reasons for exclusion of studies were documented.

## **Data extraction**

A standardised data extraction sheet was used to extract details of relevant studies using Microsoft Excel (version 2010).

## **Data items**

The data to be extracted aimed to meet the outcomes as outlined above. This was performed by DA and validated by ML. Disagreements were settled by majority decision between DA, AR and ML. Missing data were recorded as such. Duplicates were removed. Data items of interest included patient and disease characteristics, setting, and nutrition tools used. Markers of malnutrition were also identified.

## **Data synthesis**

A narrative synthesis was performed. This included reporting the frequency of nutrition tools used, the settings in which they were used, and the patient population included in the study. Included tools were reviewed to identify component items. These were mapped to ascertain 'core areas' of malnutrition used in the literature. Given this review reports a summary of how nutrition status is assessed rather than the clinical outcomes of patients, no bias assessment was performed for the studies included. This was not deemed necessary in keeping with other similar reviews(181).

## Results

### Search results

The searches identified 7,243 records, from which 543 duplicates were removed. Of the remaining 6 700 studies screened for eligibility, 6,374 studies were excluded based on title and abstract. A further two could not be retrieved. Full text review of 324 studies was performed. The majority of these were conference abstracts with no corresponding full study (**Figure 4.1**). There were 31 studies eligible for inclusion.

### Study characteristics

The summary study characteristics are detailed in **Table 4.2** (and **Table S1**). The aims of fourteen studies (45.2%) were specifically related to nutrition(8,260–272). The majority of studies enrolled fewer than 100 EGS patients(260,267,268,271–277). Seven studies included patients that all had a laparotomy(267,269,275–279). An equal number of studies (n = 15) were retrospective as were prospective (**Table S2, Table S3, Table S4, Table S5**), with one study being unspecified in this respect (**Table S6**)(265). Of the six (19.4%) multicentre studies(261–264,270,280), only three were prospective with 1,223 EGS patients (**Table S3**)(261,263,270). EGS nutrition research was globally represented, with the majority of studies in Europe (35.5%, n = 11), followed by Asia (25.8%, n = 8) then North American (22.6%, n = 7). The vast majority of studies (61.3%, n = 19) did not disclose the hospital setting the study was performed in.

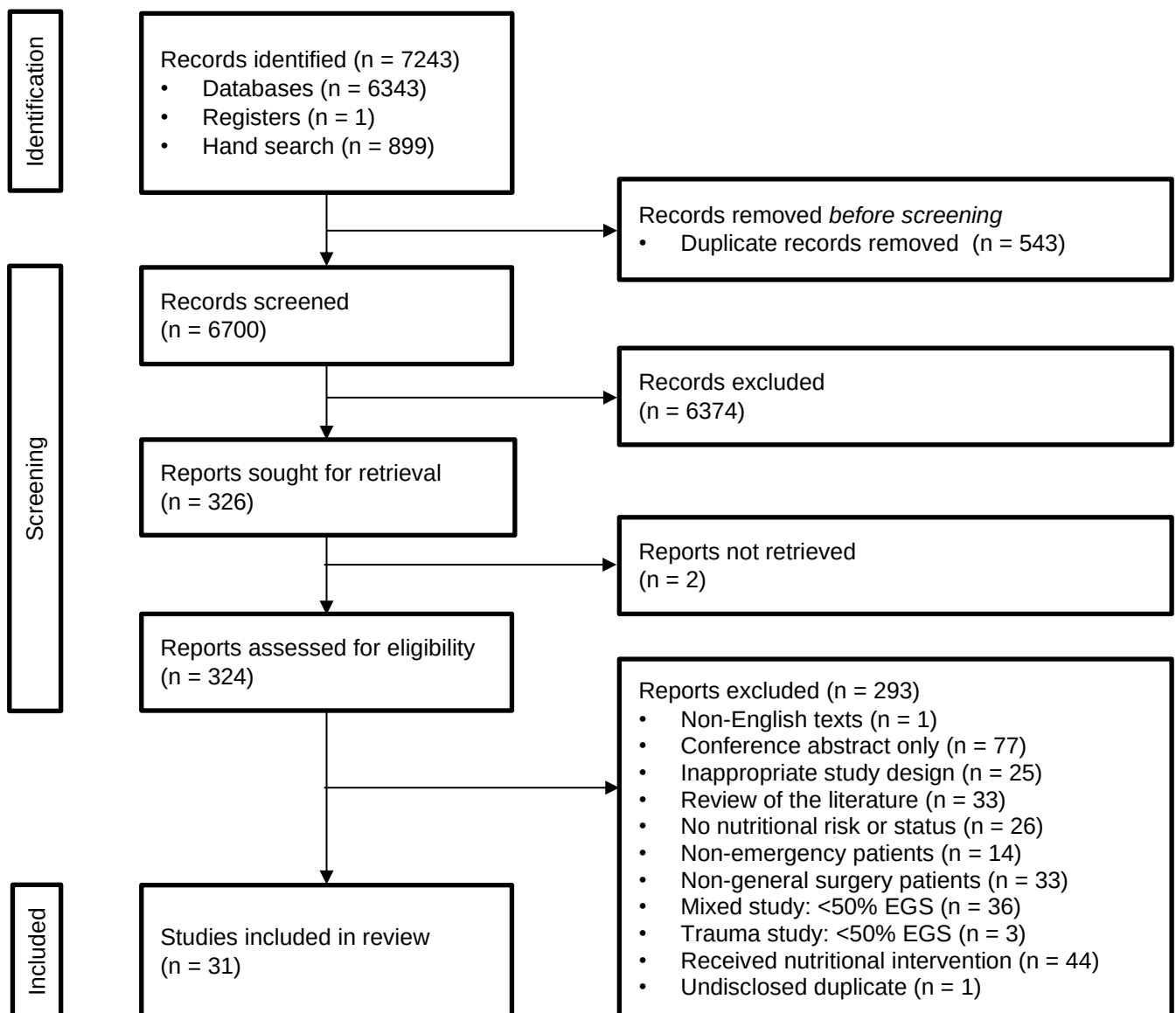


**Figure 4.1:** PRISMA flow diagram

**Table 4.2:** Summary characteristics of the included studies

| Characteristic                                                     | No. of studies n (%) |
|--------------------------------------------------------------------|----------------------|
| <b>Year</b>                                                        |                      |
| 2000-2005                                                          | 3 (9.7)              |
| 2006-2010                                                          | 2 (6.5)              |
| 2011-2015                                                          | 6 (19.4)             |
| 2016-2020                                                          | 14 (45.2)            |
| 2021-present day                                                   | 6 (19.4)             |
| <b>Type of study</b>                                               |                      |
| Retrospective                                                      | 15 (48.4)            |
| Prospective                                                        | 15 (48.4)            |
| Not stated                                                         | 1 (3.2)              |
| <b>Number of centres</b>                                           |                      |
| Single centre                                                      | 25 (80.6)            |
| Multicentre                                                        | 6 (19.4)             |
| <b>Setting</b>                                                     |                      |
| Africa                                                             | 2 (6.5)              |
| Asia                                                               | 8 (25.8)             |
| Australasia                                                        | 2 (6.5)              |
| Europe                                                             | 11 (35.5)            |
| North America                                                      | 7 (22.6)             |
| South America                                                      | 1 (3.2)              |
| <b>Hospital setting</b>                                            |                      |
| Ward                                                               | 4 (12.9)             |
| ICU                                                                | 2 (6.5)              |
| Ward and ICU                                                       | 6 (19.4)             |
| Not stated/ not applicable (follow up study)                       | 19 (61.3)*           |
| <b>Number of EGS patients included in each study</b>               |                      |
| <100                                                               | 10 (32.3)            |
| 100-199                                                            | 9 (29.0)             |
| 200-999                                                            | 8 (25.8)             |
| ≥1000                                                              | 3 (9.7)              |
| <b>Proportion of patients in studies who were EGS</b>              |                      |
| 0-49%                                                              | 3 (9.7)              |
| 50-99%                                                             | 10 (32.3)            |
| 100%                                                               | 18 (58.1)            |
| <b>Mean Patient Age</b>                                            |                      |
| <65 years                                                          | 16 (51.6)            |
| ≥65 years                                                          | 14 (45.2)            |
| Not stated                                                         | 1 (3.2)              |
| <b>Criteria for malnutrition/ at risk of malnutrition provided</b> |                      |
| Yes                                                                | 23 (74.2)            |
| No                                                                 | 8 (25.8)             |
| <b>Timing of nutritional tool</b>                                  |                      |
| On admission                                                       | 8 (25.8)             |
| Pre-operative                                                      | 7 (22.6)             |
| Post-operative                                                     | 2 (6.5)              |
| Pre- and post-operative                                            | 2 (6.5)              |
| Not stated                                                         | 12 (38.7)**          |

A total of 31 studies were included. \*One study is a follow up study(266). \*\*One study stated day 4-6 but this was not clear if it was pre- or post-operative(281).

## Definitions for malnutrition

Of the 31 studies included in this review, 75% (n = 23) of studies provided a definition of malnutrition. This was by use of a nutrition screening tool alone(263,264,270,279,282), an assessment tool(262,266,268,269,271–273,281,283) or a nutrition marker, either on its own(265,274,276) or combined(8,261,275,280,284,285). Two studies provided no definition of malnutrition(104,277). In a further six studies the definition was not explicit due to an absence of laboratory values cut offs(286), an absence of scoring system cut offs(287), absence of nutrition marker cut offs(267,278,288) or the tool used was for another reason (frailty) and malnutrition was not clearly defined within that tool or elsewhere in the study(268). Three studies used a nutritional screening tool followed by an assessment(8,260,279), although the screening tool was not stated in one study(8).

Overall, BMI was the most commonly used criteria to define malnutrition as either a primary or secondary marker of nutritional status, or as a key component of a nutritional tool, in 64.5% (n = 20) studies. Serum albumin was used as the same in 58.1% (n = 18) studies.

The range of criteria for malnutrition according to a 'core area' is mapped (**Figure 4.2**). These core areas are history, clinical examination, blood (laboratory) values, disease criteria, formulae and functional tests. Core areas have underlying themes which overlap with one another, representing the multiple criteria some studies used to define malnutrition.

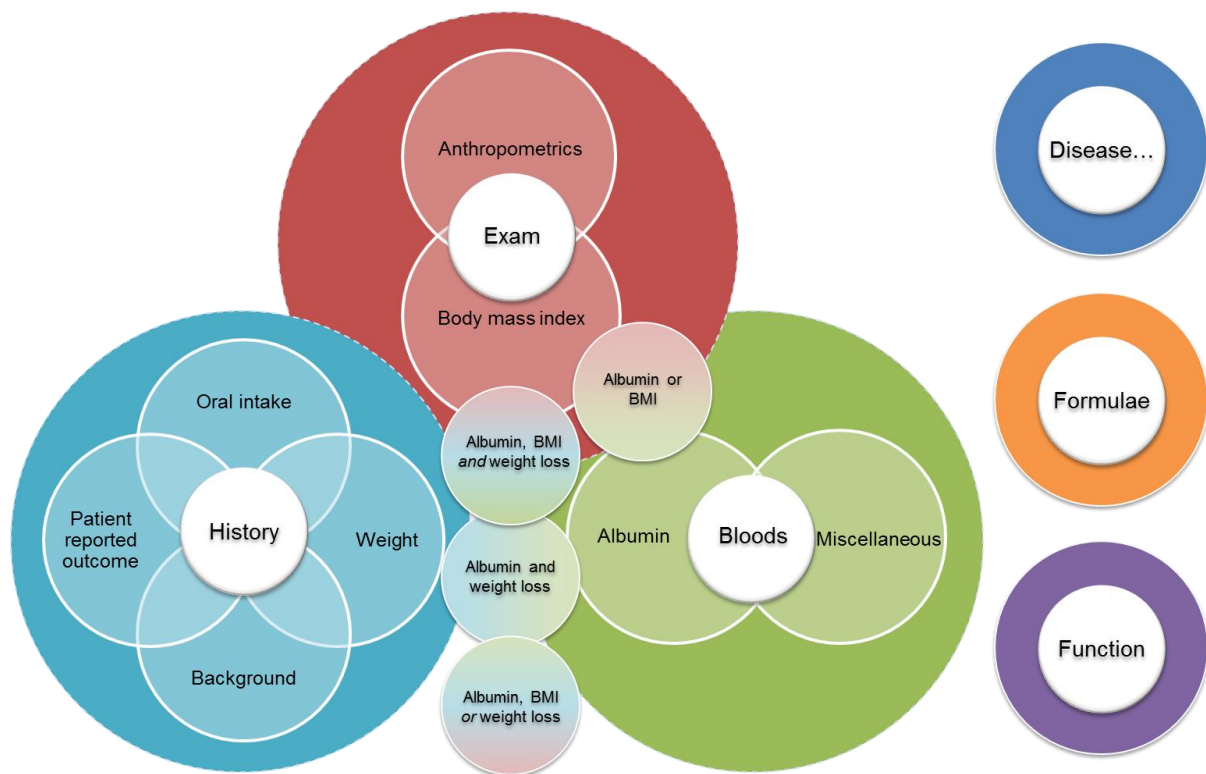


**Figure 4.2:** Definitions of malnutrition according to core area

There was considerable overlap between 'history', 'exam' and 'bloods'. Colours of circles represent overlapping core area(s). 'Disease...', 'formulae' and 'function' displayed no overlap with other criteria when defining malnutrition. Clinical examination (Exam); body mass index (BMI).

## **Nutrition screening tools**

Nutritional status was determined using a variety of methods, but each tool was used by one paper only (**Table 4.3**). There were seven nutrition screening tools or methods in use. These were the Hong Kong Chinese Malnutrition Screening Tool, the Malnutrition Screening Tool, handgrip strength, the 3-minute Nutrition Screening Tool, the Geriatric Nutritional Risk Index, the Trauma and Emergency General Surgery Frailty Index and the Canadian Nutrition Screening Tool.

### **Hong Kong Chinese Malnutrition Screening Tool (C-MUST)**

The C-MUST is a modification of the MUST which is recommended by NICE(98). Similar to MUST, BMI, unintentional weight loss and 'acute disease effect' together contribute to a total score out of six(33,47). However, C-MUST has lower cut-off values for BMI score (0 =  $\geq 18.5$  kg/m<sup>2</sup>; 1 = 16.0-18.4kg/m<sup>2</sup> and 2 =  $< 16.0$  kg/m<sup>2</sup>)(33). C-MUST is a previously validated tool in the Chinese population(289).

### **Malnutrition Screening Tool (MST)**

In this systematic review, the MST was used by one study(281). Recommended by the Academy of Nutrition and Dietetics to screen adults for malnutrition regardless of age, medical history or setting(55), the MST was developed to be as simple as possible and so no calculations are required(71). Two questions, which are 'have you been eating poorly because of a decreased appetite?' and "have you lost weight recently without trying?" determine whether a patient is at risk of malnutrition. A patient is at risk with a score of  $\geq 2$  out of 5. Previously validated against the SGA and shown to have good correlation, it has been further validated against anthropometric data, biochemical data, grip strength and length of stay(71).

### **Handgrip Strength (HGS)**

In addition to the MST, Byrnes et al examined HGS(281). HGS testing followed a standard technique with a dynamometer as described by the American Society of Hand Therapists (ASHT). Impaired HGS, defined as a value below the lower limit of the 95% confidence interval (CI) of the mean from age-, gender- and side-specific normative data, was used to determine at risk of malnutrition.

### **3-minute Nutrition Screening Tool (3-Min NST)**

The 3-min NST was used as a screening tool prior to an assessment using the SGA(279). It has five components related to unintentional weight loss over the previous six months, nutritional intake over the previous week, BMI (Kg/m<sup>2</sup>), muscle wastage from the temple and clavicle, and classifies diseases



with particular nutrition risk. A score of  $\geq 3$  indicates at risk of malnutrition, with 3-4 moderate malnutrition and 5-9 severe malnutrition.

### **Geriatric Nutritional Risk Index (GNRI)**

The GNRI is a screening tool developed specifically for elderly patients. It is developed from the formula used in the Buzby Index or Nutritional Risk Index(290). It is calculated as  $(1.489 \text{ albumin [g/L]} + (41.7 [\text{weight/ideal weight}]))$ . Malnutrition is defined as a score of  $<98$  (mild malnutrition = 92-98; moderate malnutrition = 82-92; severe malnutrition = 73-82; very severe malnutrition =  $<73$ )(34). The authors propose 87 is the ideal cut-off to assess mortality risk in the elderly(264). This study also defined malnutrition as hypoalbuminaemia ( $<3.8 \text{ g/dL}$ ) or a BMI  $<18.5$ . Albumin and BMI were used as reference criteria.

### **Trauma and Emergency General Surgery Frailty Index (TEGS FI)**

The Trauma and Emergency General Surgery Frailty Index, used by Weiss et al(282), comprises of two similar tools, one for the EGS population and one for the trauma population. They are composite tools primarily aimed to identify frailty, not malnutrition. However malnutrition is a key component, hence its inclusion here, and was defined as a hypoalbuminaemia of  $\leq 3 \text{ g/dL}$ . Hypoalbuminaemia scores you one point of a maximum 15. A patient with a score of  $\geq 4.875$  is frail. Other categories of the TEGS FI include co-morbidities, daily activities, health attitude and sexual function.

### **Canadian Nutrition Screening Tool**

The study by Saravana-Bawan et al., 2021 employed the CNST(270). Much like many of the simplest screening tools, the CNST has only two questions(291). It combines unintentional weight loss in the previous six months and a reduced nutritional intake for the past week. This is similar to the MST. The CNST indicates patients are at risk of malnutrition with two 'yes' answers. The Canadian Nutrition Society recommend that at risk patients are subsequently assessed and scored using the SGA; patients with scores B and C should be referred for an assessment by a registered dietitian(291).

**Table 4.3:** Nutrition Screening Tools in EGS

| Nutrition Screening Tool                                            | Studies                                  | Components                                                                                                                                                                                                                                                                                                                              | Score                                                                                                                                              |
|---------------------------------------------------------------------|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Hong Kong Chinese Malnutrition Screening Tool (C-MUST)*</b>      | Ho <i>et al.</i> , 2015(263)             | Body mass index<br>Weight loss in last 3-6 months<br>Acute disease precluding dietary intake for >5 days                                                                                                                                                                                                                                | Low risk = 0<br>Medium risk = 1<br>High risk = 2<br>Maximum = 6                                                                                    |
| <b>Malnutrition Screening Tool (MST)</b>                            | Byrnes <i>et al.</i> , 2018(281)         | Weight loss<br>Reduced oral intake                                                                                                                                                                                                                                                                                                      | At risk of malnutrition = $\geq 2$<br>Maximum = 5                                                                                                  |
| <b>Handgrip strength (HGS)</b>                                      | Byrnes <i>et al.</i> , 2018(281)         | Single Jamar hydraulic hand dynamometer (Lafayette Instrument, Lafayette, IN) as per standardised positioning and instruction prescribed by the American Society of Hand Therapists (ASHT), and recorded as the mean of three trials (2-4-second isometric contraction with minimum of 30-second break in between) in the dominant arm. | Impaired = Value below the lower limit of the 95% CI of the mean from age-, gender- and side-specific normative data                               |
| <b>3-min nutrition screening tool (3-Min NST)</b>                   | Chua and Chan, 2020(279)                 | Unintentional weight loss (past 6 months)<br>Reduced nutritional intake (past 1 week)<br>BMI (Kg/m <sup>2</sup> )<br>Muscle wastage (from temple and clavicle)<br>Disease with nutrition risk                                                                                                                                           | Moderate malnutrition = $\geq 3$ (study cut off)<br>At risk of malnutrition = $\geq 3$<br>Moderate malnutrition = 3-4<br>Severe malnutrition = 5-9 |
| <b>Geriatric Nutritional Risk Index (GNRI)</b>                      | Jia <i>et al.</i> , 2020(264)            | Formula based on the Buzby index/ NRI<br>$(1.489 \text{ albumin [g/L]} + (41.7 [\text{weight/ideal weight}]))$<br><br>*Jia et al also compared to albumin and body mass index                                                                                                                                                           | Normal = $>98$<br>Mild malnutrition = 92-98<br>Moderate malnutrition = 82-92<br>Severe malnutrition = 73-82<br>Very severe malnutrition = $<73$    |
| <b>Trauma and Emergency General Surgery Frailty Index (TEGS FI)</b> | Weiss <i>et al.</i> , 2020(282)          | A composite tool with several categories designed to identify frailty:<br>Co-morbidities<br>Daily activities<br>Health Attitude<br>Function<br>Nutrition (albumin $<3\text{g/dL}$ )                                                                                                                                                     | Albumin $<3\text{g/dL}$ = 1<br>Albumin $>3\text{g/dL}$ = 0<br>Maximum = 15<br>TEGS frail = $\geq 4.875$                                            |
| <b>Canadian Nutrition Screening Tool (CNST)**</b>                   | Saravana-Bawan <i>et al.</i> , 2021(270) | Unintentional weight loss (past 6 months)<br>Reduced nutritional intake (past 1 week)                                                                                                                                                                                                                                                   | At risk of malnutrition = 2 'Yes'                                                                                                                  |

\*The difference between C-MUST and MUST is the lower cut off values for BMI score. \*\*CNST is based on MST but the score is dichotomised (yes/ no) rather than points based.

## **Nutrition assessment tools**

There were nine nutrition assessment tools, of which the most commonly used was the Subjective Global Assessment (SGA) tool. A summary of these tools is presented according to year published (**Table 4.4**). Nutrition screening and assessment tools according to 'core areas' are also presented (**Table 4.5** and **Table S7**).

### **Prognostic Nutrition Index (PNI)**

The PNI is a mathematical equation using albumin (g/dL), triceps skin fold thickness (mm), serum transferrin (mg/dL) and a skin delayed hypersensitivity test to any of four recall antigens. It is calculated as  $PNI (\%risk) = 158 - 16.6 (\text{albumin}) - 0.78 (\text{triceps skin fold}) - 0.20 (\text{serum transferrin}) - 5.8 (\text{delayed hypersensitivity})$ . The original Buzby PNI was used to identify patients at risk of post-operative complications(292). Patients with a PNI score of  $\leq 40\%$  were low risk, 40-50% were intermediate risk, and  $\geq 50\%$  were high risk. The PNI was used by two studies(269,271).

### **Subjective Global Assessment (SGA)**

The SGA, used by three studies(266,269,279), is a composite tool based on patient history including weight change, dietary intake, gastrointestinal symptoms, functional capacity, disease and metabolic demand, as well as clinical examination including loss of subcutaneous muscle, muscle wasting, ankle oedema, sacral oedema or ascites(89). A subjective rating of nutrition risk is made. The categories patients can be assigned are well nourished (A), moderately malnourished (B) or severely malnourished (C).

### **Patient-Generated Subjective Global Assessment (PG-SGA)**

The PG-SGA, used in two studies(273,281), is identical to the SGA except that the history component is completed by the patient themselves. A subjective classification of well nourished (A) and moderately (B) or severely (C) malnourished as decided by the healthcare professional remains.

### **Geriatric 8 (G8)**

Similar to the TEGS FI, the Geriatric 8 score is a composite tool primarily aimed to predict frailty and postoperative morbidity and mortality. However, of the eight questions, seven are based on the Mini Nutritional Assessment Short Form (MNA SF). Reduced intake over the past three months and BMI are two of the eight components of nutritional relevance in the G8(293). Patients can score a maximum of 17, and a score of  $\leq 14$  demonstrates frailty.

### **Nutrition Risk Index (NRI)/ Buzby index**

The NRI, used in a study by Mambou et al(268), is another formula-based nutritional index. It is calculated by  $(1.519 \times \text{serum albumin (g/L)} + (0.417 \times \text{actual weight/ideal weight}))$ . The original Buzby index is  $(15.9 \times \text{serum albumin, g/L}) + (0.417 \times (\% \text{usual body weight}))$ , where percentage usual body weight is current weight as a percentage of usual weight either two or six months ago(290,294). If percentage usual body weight is  $>100\%$ , 100% is used in the equation. Note that patients of the original study by Buzby et al were included if they were malnourished as defined by either of two nutritional criteria: the NRI, or at least two criteria from current weight  $\leq 95\%$  of ideal weight, albumin  $\leq 39.2$  g/L or pre-albumin  $\leq 0.186$  g/L(290).

### **Mini Nutritional Assessment Short Form (MNA SF)**

The MNA SF(77), an abbreviated version of the MNA, has six components and was used by one study(283). These include reduced intake over three months, BMI and involuntary weight loss. Calf circumference could be used if BMI could not be obtained. Other components include mobility, psychological stress or acute disease, or neuropsychological problems (such as dementia). A maximum score of 14 is possible. Patients scoring 0-7 are malnourished, whilst those scoring 8-11 are at risk of malnutrition.

### **modified Glasgow Prognostic Score (mGPS)**

The mGPS is a crude measure and used by one study only(271). It uses two biochemical markers to indicate malnutrition, C-reactive protein (CRP) and albumin. A score of two is required for a diagnosis of malnutrition, and this is achieved with a CRP  $>10$ /L + albumin  $<3.5$ g/dL.

### **Mini-Nutritional Assessment (MNA) Full Form**

One study used the MNA(272). The MNA has 18 questions in four sections(77,78). These relate to an anthropometric assessment, a general assessment, a dietary assessment and a self-assessment. A score of  $\geq 24$  of a maximum 30 is normal. Malnourished patients will score  $<17$ , whilst those at risk of malnutrition score 17-23.5.

### **modified Global Leadership Initiative in Malnutrition (mGLIM)**

The mGLIM criteria was adapted from the Global Leadership Initiative in Malnutrition (GLIM) definition of malnutrition(101) in order to be able to apply them to American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) data. Muscle mass and food intake is not gathered routinely on the ACS-NSQIP. As such, mGLIM included BMI, weight loss, acute disease/injury

represented by EGS patients and a surrogate marker of inflammation which was low admission albumin ( $\leq 3.5$  g/dL)(262). A diagnosis of malnutrition was defined as patients having all four criteria.

**Table 4.4:** Nutrition Assessment Tools in EGS

| Nutrition Assessment Tool                                      | Studies                                                                                           | Components                                                                                                                                                                                                                                                                                                                                                                                                 | Score                                                                                                                                |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <b>Prognostic Nutrition Index (PNI)</b>                        | Mohil <i>et al.</i> , 2008(269);<br><i>Takano et al.</i> , 2021(271)                              | PNI (%risk) = $158 - 16.6 (\text{Alb}) - 0.78 (\text{TSF}) - 0.20 (\text{TFN}) - 5.8 (\text{DH})$<br>Where Alb = albumin (g/dL); TSF = triceps skin fold thickness (mm), TFN = serum transferrin (mg/dL), DH = skin test reactivity; delayed hypersensitivity to any of four recall antigens.<br><br><i>Original Buzby PNI index was used to identify patients at risk of postoperative complications.</i> | Low risk = <40%<br>Intermediate risk = 40-50%<br>High risk = ≥50%<br><br><i>These match the original Buzby scoring criteria too.</i> |
| <b>Subjective Global Assessment (SGA)</b>                      | Koziel <i>et al.</i> , 2017(266);<br>Mohil <i>et al.</i> , 2008(269);<br>Chua and Chan, 2020(279) | A composite tool of patient history and a physical examination with a subjective rating of nutrition risk.<br>History: Weight change (past 6 months and past 2 weeks); dietary intake; gastrointestinal symptoms; functional capacity; disease and metabolic demand; physical examination including loss of subcutaneous muscle, muscle wasting, ankle oedema, sacral oedema or ascites                    | Well-nourished = SGA A<br>Moderate malnutrition = SGA B<br>Severe malnutrition = SGA C                                               |
| <b>Patient-Generated Subjective Global Assessment (PG-SGA)</b> | Daniele <i>et al.</i> , 2015(273);<br>Byrnes <i>et al.</i> , 2018(281)                            | As per the SGA except that the medical history is completed by the patient themselves. A subjective classification of degree of risk by a healthcare professional remains.                                                                                                                                                                                                                                 | Well-nourished = PG-SGA A<br>Moderate malnutrition = PG-SGA B<br>Severe malnutrition = PG-SGA C                                      |
| <b>Geriatric 8 (G8)</b>                                        | Kenig <i>et al.</i> , 2015(293)                                                                   | The G8 score is composed of eight questions, seven based on the MNA.<br>Reduced intake past 3 months<br>Involuntary weight loss<br>Mobility<br>Neuropsychological problems<br>BMI<br>Polypharmacy<br>Self-assessment (global in comparison to others of similar age)<br>Age                                                                                                                                | Frail ≤14<br>Non frail >14<br>Maximum = 17                                                                                           |

|                                                        |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                |
|--------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| <b>Nutrition Risk index (NRI)/ Buzby index</b>         | Mambou Tebou <i>et al.</i> , 2017(268)  | <p>Formula used in study:<br/> <math>NRI = (1.519 \times \text{serum albumin (g/L)} + (0.417 \times \text{actual weight/ideal weight}))</math></p> <p><i>Original Buzby index:</i><br/> <math>NRI = (15.9 \times \text{serum albumin, g/L}) + (0.417 \times (\% \text{usual body weight}))</math><br/> Where percentage usual body weight is current weight as a percentage of usual weight either 2 or 6 months ago(290)</p>                                                                                                 | <p>Mild malnutrition = &gt;97.5<br/> Moderate malnutrition = 83.5–97.5<br/> Severe malnutrition = &lt;83.5</p> |
| <b>Mini Nutritional Assessment Short Form (MNA SF)</b> | Fuertes-Guiró <i>et al.</i> , 2019(283) | <p>Based on the MNA, this is a composite of 6 components:<br/> Reduced intake past 3 months<br/> Involuntary weight loss<br/> Mobility<br/> Psychological stress or acute disease in past 3 months<br/> Neuropsychological problems (dementia)<br/> BMI (or CC if unable to obtain BMI)</p>                                                                                                                                                                                                                                   | <p>Normal = 12–14<br/> At risk of malnutrition = 8–11<br/> Malnourished = 0–7<br/> Maximum = 14</p>            |
| <b>modified Glasgow Prognostic Score (mGPS)</b>        | Takano <i>et al.</i> , 2021(271)        | <p>CRP ≤10mg/ + any albumin = 0<br/> CRP &gt;10mg/L + albumin ≥3.5g/dL = 1<br/> CRP &gt;10/L + albumin &lt;3.5g/dL = 2</p>                                                                                                                                                                                                                                                                                                                                                                                                    | <p>Malnutrition = 2</p>                                                                                        |
| <b>Mini-Nutritional Assessment (MNA) Full Form</b>     | Welch <i>et al.</i> , 2022(272)         | <p>A composite of 18 questions relating to:<br/> Anthropometric assessment (BMI, MAC, CC, weight loss past 3 months)<br/> General assessment (independent living, polypharmacy, psychological stress or acute disease in past 3 months), mobility, neuropsychological problems, pressure ulcers)<br/> Dietary assessment (number of daily meals, composition of meals, mode of feeding)<br/> Self-assessment (nutritional – do they think they have a nutritional problem, global in comparison to others of similar age)</p> | <p>Normal = ≥ 24<br/> At risk of malnutrition = 17–23.5<br/> Malnourished = &lt;17<br/> Maximum = 30</p>       |

|                                                                      |                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                      |
|----------------------------------------------------------------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>modified Global Leadership Initiative in Malnutrition (mGLIM)</b> | Haines <i>et al.</i> , 2021(262) | An adapted set criteria in order to apply GLIM definitions to NSQIP data.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | All 4 criteria (mGLIM positive) = malnourished                                                                                                                                                                       |
|                                                                      |                                  | <p>Phenotypic GLIM malnutrition criteria</p> <p>Low BMI (<math>\leq 20</math> in patients aged <math>\leq 70</math> years and BMI <math>\leq 22</math> in patients aged <math>&gt; 70</math>)</p> <p>Recent weight loss (<math>&gt; 5\%</math> within the last six months, or <math>&gt; 10\%</math> beyond six months)</p> <p><i>Reduced muscle mass by a validated technique measured (not included)</i></p>                                                                                                                                                                                                            | <p><i>GLIM criteria requires patients to be identified as at risk of malnutrition using a validated risk tool, and a subsequent diagnosis of malnutrition based on 1 phenotypic and 1 aetiological criteria.</i></p> |
|                                                                      |                                  | <p>Aetiological GLIM malnutrition criteria</p> <p>Acute disease/injury represented by EGS patients (the NSQIP database) and a surrogate marker of inflammation (low admission albumin, <math>\leq 3.5</math> g/dL). A decreased albumin is a widely utilized NSQIP definition of pre-operative malnutrition but is not part of GLIM criteria.</p> <p><i>Reduced food intake or assimilation (<math>\leq 50\%</math> energy requirements for <math>&gt; 1</math> week, or any reduction for <math>&gt; 2</math> weeks), or any GI conditions that adversely effects food assimilation of absorption (not included)</i></p> |                                                                                                                                                                                                                      |

Abbreviations: albumin (Alb); body mass index (BMI); calf circumference (CC); C-reactive protein (CRP); delayed hypersensitivity to any of four recall antigens (DH); mean arm circumference (MAC); National Surgical Quality Improvement Program (NSQIP); serum transferrin (TFN); triceps skin fold thickness (TSF). Note Sánchez Acedo *et al* (2020) used the MNA SF but no cut off values were provided; only two criteria given (no malnutrition, malnourished) when MNA SF has three (no malnutrition, at risk, malnourished). Additional GLIM criteria in italics.



**Table 4.5:** Nutrition screening and assessment tools according to ‘core area’

|                                          | Oral intake | Patient reported outcome | Patient's background | Weight | BMI | Anthropometrics | Albumin | Disease | Function |
|------------------------------------------|-------------|--------------------------|----------------------|--------|-----|-----------------|---------|---------|----------|
| <b>Nutrition Screening Tools in EGS</b>  |             |                          |                      |        |     |                 |         |         |          |
| <b>C-MUST*</b>                           | .           | .                        | .                    | X      | X   | .               | .       | X       | .        |
| <b>MST</b>                               | X           | .                        | .                    | X      | .   | .               | .       | .       | .        |
| <b>HGS</b>                               | .           | .                        | .                    | .      | .   | .               | .       | .       | X        |
| <b>3-Min NST</b>                         | X           | .                        | .                    | X      | X   | X               | .       | X       | .        |
| <b>GNRI</b>                              | .           | .                        | .                    | X      | .   | .               | X       | .       | .        |
| <b>TEGS FI</b>                           | .           | X                        | X                    | .      | .   | .               | X       | .       | X        |
| <b>CNST**</b>                            | X           | .                        | .                    | X      | .   | .               | .       | .       | .        |
| <b>Nutrition Assessment Tools in EGS</b> |             |                          |                      |        |     |                 |         |         |          |
| <b>PNI</b>                               | .           | .                        | .                    | .      | .   | X               | X       | .       | .        |
| <b>SGA</b>                               | X           | .                        | X                    | X      | .   | X               | .       | X       | X        |
| <b>PG-SGA</b>                            | X           | .                        | X                    | X      | .   | X               | .       | X       | X        |
| <b>G8</b>                                | X           | X                        | X                    | X      | X   | .               | .       | .       | X        |
| <b>NRI</b>                               | .           | .                        | .                    | X      | .   | .               | X       | .       | .        |
| <b>MNA SF</b>                            | X           | .                        | X                    | X      | X   | X               | .       | X       | X        |
| <b>mGPS</b>                              | .           | .                        | .                    | .      | .   | .               | X       | .       | .        |
| <b>MNA Full Form</b>                     | X           | X                        | X                    | X      | X   | X               | .       | X       | X        |
| <b>mGLIM</b>                             | .           | .                        | .                    | X      | X   | .               | X       | X       | .        |

\*The difference between C-MUST and MUST is the lower cut off values for BMI score. \*\* CNST is based on MST but the score is dichotomised (yes/ no) rather than points based.

Abbreviations (in order of table): Hong Kong Chinese Malnutrition Universal Screening Tool (C-MUST); Malnutrition Screening Tool (MST); handgrip strength; 3-minute Nutrition Screening Tool (3-Min NST); Geriatric Nutrition Risk Index (GNRI); Trauma and Emergency General Surgery Frailty Index (TEGS FI); Canadian Nutrition Screening Tool (CNST); Prognostic Nutrition Index (PNI); Subjective Global Assessment (SGA); Patient-Generated Subjective Global Assessment (PG-SGA); Geriatric 8 (G8); Nutrition Risk Index (NRI); Mini Nutritional Assessment Short Form (MNA SF); modified Glasgow Prognostic Score (mGPS); Mini-Nutritional Assessment (MNA) Full Form; modified Global Leadership Initiative in Malnutrition (mGLIM)

## **Alternate nutrition markers (single measures)**

There were seven single measures used to define malnutrition (**Table 4.6**). These included albumin, arm muscle circumference, BMI, cholinesterase, haemoglobin, neutrophil to lymphocyte ratio and the total number of lymphocytes. Albumin(266,271,274,276,286) and BMI(104,265,266,271,288) were the most commonly used in five studies each.

### **Albumin**

A range of albumin levels were used in studies. In two studies(271,286), no cut off was stated explicitly. Another two studies defined malnutrition as hypoalbuminaemia  $\leq 3.5\text{g/dL}$ (266,274), whilst a third study used albumin levels of  $\leq 3.0\text{g/dL}$ (276).

### **Body Mass index (BMI)**

As with albumin, a range of BMI values were used to define malnutrition. One study used  $<18.5\text{Kg/m}^2$ , which is in keeping with NICE(98) and ESPEN(106). Two studies used BMI  $<20\text{Kg/m}^2$ (266,271). Another study described patients as 'dystrophic' with BMI  $<21$  or  $\geq 30\text{Kg/m}^2$ (288). Finally, one study focussed on patients with obesity(104). It is not clear whether 'dystrophic' patients or patients with a BMI  $>35\text{Kg/m}^2$  were considered malnourished.

**Table 4.6:** Alternate nutrition markers in EGS (single measures)

| Nutrition Measure                     | Studies                                                                  | Criteria                                                                                                                                                                                                                         |
|---------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Albumin</b>                        | Farrah <i>et al.</i> , 2013(286)                                         | Admission albumin (cut off NS)                                                                                                                                                                                                   |
|                                       | Koziel <i>et al.</i> , 2017(266);<br>Fernandes <i>et al.</i> , 2019(274) | Malnutrition: albumin $\leq 3.5$ g/dL                                                                                                                                                                                            |
|                                       | Krishna <i>et al.</i> , 2019(276)                                        | Preoperative albumin (reference value 3.5–5.5 g/dL) was used as an indicator of the nutritional status of the patients. Significant hypoalbuminemia (ie malnutrition) = 3.0 g/dL.                                                |
|                                       | Takano <i>et al.</i> , 2021(271)                                         | Preoperative levels (cut off NS, although Table 3 suggests $<3.6$ g/dL)                                                                                                                                                          |
| <b>Arm muscle circumference (AMC)</b> | Koziel <i>et al.</i> , 2017(266)                                         | Anthropometric examinations (measurements of body weight, height, arms, waist, hip circumference, and the measurement of skinfold thickness) were used to calculate the body mass index (BMI) and arm muscle circumference (AMC) |
| <b>Body Mass index (BMI)</b>          | Khan <i>et al.</i> , 2016(265)                                           | Malnourished: BMI $<18.50$ ; Properly nourished: BMI 18.50-24.99                                                                                                                                                                 |
|                                       | Koziel <i>et al.</i> , 2017(266);<br>Takano <i>et al.</i> , 2021(271)    | Malnourished: BMI $<20$ Kg/m <sup>2</sup>                                                                                                                                                                                        |
|                                       | Küpper <i>et al.</i> , 2015(104)                                         | Patients with a BMI $>35$ were included, although it was not clear that this constituted ‘malnutrition’.                                                                                                                         |
|                                       | Serejo <i>et al.</i> , 2007(288)                                         | Dystrophic: BMI $<21$ or $\geq 30$ ; Eutrophic: $\geq 21$ - $<30$ . It was not clear if dystrophia constituted ‘malnutrition’.                                                                                                   |
|                                       | Takano <i>et al.</i> , 2021(271)                                         | Preoperative levels; malnutrition: $<199$ U/L                                                                                                                                                                                    |
| <b>Haemoglobin</b>                    | Takano <i>et al.</i> , 2021(271)                                         | Preoperative levels; NS although table 3 suggests $<12.3$ g/dL                                                                                                                                                                   |
| <b>Neutrophil to lymphocyte ratio</b> | Takano <i>et al.</i> , 2021(271)                                         | Preoperative levels; NS                                                                                                                                                                                                          |
| <b>Total number lymphocytes (TNL)</b> | Koziel <i>et al.</i> , 2017(266)                                         | TNL $<1,200$ in 1 mm <sup>3</sup> blood<br>To determine the weakening of immune resistance that accompanies malnutrition, the TNL was determined by:<br>TNL = (% of lymphocytes x number of lymphocytes)/100                     |

Abbreviations: Arm muscle circumference (AMC); body mass index (BMI); cholinesterase (ChE); not stated (NS); total number lymphocytes (TNL).

### **Alternate nutrition markers (combined measures)**

There were seven combined measures used to define malnutrition between nine studies(8,261,264,267,275,278,280,284,285). Hypoalbuminaemia was a key factor in eight of these. The combined measures included: appetite and weight loss; albumin and weight loss; albumin, BMI or weight loss; albumin, BMI and weight loss; albumin or BMI; a complex combined measure of weight loss, underweight based on ideal weight, muscle wasting and inadequate protein energy intake; and, BMI, arm circumference and skin fold thickness (**Table 4.7**).

**Table 4.7:** Alternate nutrition markers in EGS (combined measures)

| Nutrition Measure                                                                                                                                                                                                                                                         | Studies                                | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Appetite and weight loss</b>                                                                                                                                                                                                                                           | Barazanchi <i>et al.</i> , 2020(278)   | Any weight loss in past 6-months and a recent reduction in appetite (reported by patients)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Albumin and weight loss</b>                                                                                                                                                                                                                                            | Mäkelä <i>et al.</i> , 2005(285)       | Malnourished: albumin <35g/L and weight loss in past 6 months                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                                                                                                                                                                                                                                                           | Mäkelä <i>et al.</i> , 2005(284)       | Malnourished if they had a serum albumin value under 35 g/l and had experienced a weight loss of over 5 kg during the past few months.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Albumin, BMI or weight loss</b>                                                                                                                                                                                                                                        | Kenig <i>et al.</i> , 2012(275)        | Malnutrition: a decreased albumin level <30 g/L, or decreased body weight ≥10% or BMI <20.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Albumin, BMI and weight loss</b>                                                                                                                                                                                                                                       | Novy <i>et al.</i> , 2021(280)         | Mild malnutrition (at least one of the following) <ul style="list-style-type: none"> <li>BMI &lt;21, weight loss 5% in 1 month or weight loss 10% in 6 months, albuminemia &lt;35g/L</li> </ul> Severe malnutrition (at least one of the following): <ul style="list-style-type: none"> <li>BMI &lt; 18, weight loss 10% in 1 month, weight loss 15% in 6 months, albuminemia &lt;30g/L</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                                                                                                                                                                                                           |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Albumin or BMI</b>                                                                                                                                                                                                                                                     | Fentahun <i>et al.</i> , 2021(261)     | Malnourished: BMI <18.5 or >24.9; Well nourished: BMI >18.5-24.9<br>Malnourished: albumin: <3.5 g/dl                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                                                                                                                                                                                                                                                           | Jia <i>et al.</i> , 2020(264)          | Malnourished: albumin <3.8 g/dL or BMI <18.5 (used to compare to GNRI)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Disease-related weight loss, underweight status based on percent ideal body weight, muscle wasting, inadequate energy or protein intake</b><br>*Laboratory parameters are used in patients not considered to have inflammation or infection (exclusion criteria apply) | Havens <i>et al.</i> , 2018(8)         | Severe Protein-Energy Malnutrition (three of the following criteria must be met): <ul style="list-style-type: none"> <li>Significant, disease-related, weight loss of &gt; 15% of usual weight within the past six months; &lt; 70% ideal body weight; pre-admission serum albumin &lt; 2.1 g/dL; TLC ≤ 800 mm<sup>3</sup>; transferrin &lt; 100 mg/dL; overt signs of muscle wasting on physical exam; inadequate energy intake (&lt;50% of estimated needs for 3 days or &lt;75% of estimated needs for 7 days)</li> </ul> Moderate Protein-Energy Malnutrition (two of the following criteria must be met): <ul style="list-style-type: none"> <li>Significant, disease-related, weight loss of 10%-15% of usual weight within the past six months; 70%-84% of ideal body weight; pre-admission serum albumin 2.1 g/dL-2.7 g/dL; TLC 800-1199 mm<sup>3</sup>; transferrin 100-149 mg/dL</li> </ul> Mild Protein-Energy Malnutrition (two of the following criteria must be met): <ul style="list-style-type: none"> <li>Significant, disease-related, weight loss of 5%-9% of usual weight within the past six months; 85%-94% of ideal body weight; pre-admission serum albumin 2.8-3.4 g/dL; TLC 1200-1499 mm<sup>3</sup>; transferrin 150-199 mg/dL</li> </ul> Non-Specific Protein-Energy Malnutrition <ul style="list-style-type: none"> <li>Known nutritional risk with metabolic stress and/or overt signs of malnutrition without supporting anthropometric or biochemical data. Clinical judgment is required to make this classification</li> </ul> |
| <b>BMI, MUAC and skin fold thickness</b>                                                                                                                                                                                                                                  | Lalhruaizela <i>et al.</i> , 2020(267) | No criteria given regarding mid upper arm circumference or skin fold thickness, however BMI <18.5 was considered 'low' (no clear whether this meant malnourished).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Abbreviations: Body mass index (BMI); Geriatric Nutrition Risk Index (GNRI); mean upper arm circumference (MUAC); total leucocyte count (TLC).

## Implementation of a nutritional tool

Patients' nutritional status was assessed at a number of time points. Almost half of the studies (48.4%, n = 15) performed the assessment on admission or pre-operatively (**Table 4.2**).

## Discussion

This systematic review reports the current methods used to identify malnutrition in emergency general surgery. Within the 31 included studies, a range of approaches were used. These included seven nutrition screening tools, nine nutrition assessment tools, seven single nutrition markers, and seven combined measures used to define malnutrition. There is considerable heterogeneity in 'core areas' in the tools used in EGS research and their components (**Figure 4.2**, **Table 4.5** and **Table S7**).

The findings in this review likely reflect the inconsistency among guidelines, and the absence of a universal definition for malnutrition. NICE suggest the Malnutrition Universal Screening Tool (MUST) to screen for malnutrition in the UK, and this is widely adopted(98). The European Society for Clinical Nutrition and Metabolism (ESPEN) recognises a number of tools that can be used in a hospital setting. These include the Nutritional Risk Score 2002 (NRS 2002), the Mini Nutritional Assessment-Short Form (MNA-SF) and MUST(106). ESPEN's guidelines on nutrition in critically ill patients advise a general clinical assessment of nutrition should be performed until a specific tool has been validated, although every patient in ICU for more than 48 hours should be considered high risk for malnutrition(99). Conversely, the Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition (ASPEN) advise using nutritional risk screening tools such as the NRS 2002 or Nutrition Risk in Critically ill (NUTRIC)(109). The Global Leadership Initiative on Malnutrition (GLIM) guidelines state that screening should be performed using a validated screening tool and although none is recommended, tools such as the NRS 2002, MNA-SF, MUST and the Subjective Global Assessment (SGA) tool are presented(101).

Only one study implemented a tool that is recommended by current guidelines. Fuertes-Guiró, Vitali-Erion and Rodriguez Fernandez studied 286 elderly EGS patients in a single centre study using the MNA-SF(283). They identified 29% ( $n = 84$ ) of patients were malnourished with a subsequent associated risk of postoperative mortality (odds ratio = 1.57,  $p$  value = 0.14). A further 32% ( $n = 91$ ) of patients were at risk of malnutrition with a significant risk of postoperative mortality (odds ratio = 1.89,  $p$ -value = 0.032).

The identification of malnutrition is a two-step process; screening of patients who may be at risk of malnutrition is followed by an assessment to confirm the diagnosis, categorise and plan treatment. This is recognised by the British Dietetic Association(54) and overseas by The Academy of Nutrition and Dietetics(55), as well as a number of guidelines. The nutritional assessment is typically performed by a trained professional(101). GLIM endorse phenotypic (weight loss; body mass index; muscle mass)

and aetiologic criteria (food intake or assimilation; inflammation or disease burden) can be used for a diagnosis of malnutrition, although consultation with a trained professional is recommended for a comprehensive assessment(101). Only three studies used a nutritional screening tool followed by an assessment(8,260,279), although the screening tool was not stated in one study(8). Of these three studies, the assessment of malnutrition was done by a dietitian in one study alone(8). The absence of this two-step process in EGS research likely has two effects.

First, it leads to confusion within the literature, and possibly clinical practice, regarding what is meant by an 'assessment' of nutritional status. Some tools exist as nutrition 'assessment' tools in that a more global assessment is performed. Others are simply named assessment tools but may be no more complex than a screening tool. Consequently, assessment tools are conflated with screening tools and vice versa. For example, the SGA has been evaluated in many studies comprised of all types of adult in-patients(59). It has subsequently become considered a gold standard for which other tools are assessed(59). This is despite it being a subjective process with minimal 'assessment'.

Second, the absence of a two-step process adds to the heterogeneity of EGS research which is already a labyrinth of complex diagnostic, investigative, and management processes. This may further hamper the development of comparable studies and translation of malnutrition identification into routine practice. Of the nine 'assessment' tools in this review, three are based on formula (Prognostic Nutrition Index (PNI), Nutrition Risk Index (NRI) and the modified Glasgow Prognostic Score (mGPS)), two are subjective (SGA, Patient-Generated SGA (PG-SGA)) and three are aimed at identifying malnutrition within the framework of frailty (the Mini Nutritional Assessment (MNA), MNA Short Form (MNA SF), Geriatric 8 (G8)). This reiterates the above issue, and likely does not accurately reflect the experience a trained professional would bring when performing a nutritional assessment.

Finally, albumin has often historically been regarded as a marker of nutritional status(93), and there remains a degree of controversy with respect to its role in assessing malnutrition(91,92). This study found albumin was used in more than half of studies as a primary or secondary marker of malnutrition. It clearly has a role in the inflammatory state as a negative acute phase marker, the post-operative stress response and determining disease severity; all of which may impact nutrition. Moreover, hypoalbuminaemia is associated with increased mortality and morbidity(94,295), and waiting for this to normalise pre-operatively reduces these risks(296). However, there is inadequate evidence for its direct role in determining nutritional status(297). Indeed, it does not help in deciding which patients



should receive nutritional support(96), and a normal albumin level can be seen despite severe malnutrition(97).

A number of international bodies advise against the use of albumin as a marker for malnutrition. NICE recommend that low albumin is more likely to be a reflection of acute disease rather than malnutrition(98). ESPEN support this but reiterate hypoalbuminaemia is a surgical risk factor in its own right(43,99). ASPEN categorically state albumin and pre-albumin should not be used as nutrition markers(100), and GLIM state that albumin is a proxy marker of inflammation only(101). Although albumin may have a role in prognostication for surgical outcomes, the use of albumin as a marker of the current state of malnutrition should be abandoned, clinically and in future studies.

It is important to recognise however, that a patient's nutrition status is a dynamic process, and as such, so should be the process of identifying it. To begin with, there is the patient's pre-existing nutritional status. They may be underweight, exhibit a degree of chronic malnutrition or ever-increasingly in the Western world, be overweight or obese. The subsequent treatment and management of their diagnosis, as well as future possibilities such as a persisting ileus or reduced oral intake will also affect a patient's nutritional status. Whilst almost half of the studies determined nutrition status on admission or pre-operatively, it was not stated in close to 40% of studies (**Table 4.2**) and certainly many studies did not comment on whether patients were reassessed (data not stated).

## **Strengths of the study**

This systematic review benefits from exploring a research question with direct relevance to a large proportion of acute surgical admissions. It was registered prospectively and had wide inclusion criteria allowing for studies of adult patients with a general surgical diagnosis to be included, whether managed conservatively and operatively.

## **Limitations of the study**

This study is not without limitations. Firstly, although more than half of the included studies (58.1%, n = 18) were confined to EGS patients, mixed patient populations (mixed surgical specialty, emergency and elective general surgical, surgical and medical, or trauma patients) were also eligible for inclusion, with the EGS group extracted. Although consideration was given to limit studies only to those of patients with 'high risk' EGS diagnoses such as those defined by Symons *et al*(9) or those using National Emergency Laparotomy Audit (NELA) database criteria or similar(24), this would have led to paucity

of data. Three studies had fewer than 50% EGS patients(263,272,277). The inclusion of these studies did not lead to irrelevant nutrition screening or assessment tools that were more targeted to populations other than EGS. Ho *et al* was one of only three multicentre studies examining adult surgical patients undergoing elective and emergency operations on the luminal gastrointestinal tract(263). They used C-MUST, which is based on the MUST and has been extensively validated and is widely used in the UK(75). The second study, by Waqar *et al.*(277), examined patients that have had a laparotomy in the elective, emergency and trauma setting. In this study by Waqar *et al.*(277), no definition of malnutrition is offered, although this was the case in a quarter of studies in this review. Lastly, the study by Welch *et al* in which only 19.8% (n = 16) patients were EGS, assessed the feasibility of conducting acute sarcopenia research(272). This study used the MNA. It is a well-validated tool for older populations and has questions relating to a range of anthropometric measures including weight loss and BMI, and a dietary assessment(298).

Finally, this review did not correlate how malnutrition was identified with the range of diagnoses, clinical outcomes or patient-reported outcomes in EGS. This was not in the initial remit of the review, although it was noted that there were inconsistencies in reporting clinical outcomes. In addition to the various study designs, this would have been difficult to interpret and generate meaningful conclusions.

## **Findings in context and future research**

Given there is a wide variation in study design, population, definitions and the nutrition tools and markers used to determine malnutrition in EGS, caution must be obeyed when interpreting the findings of these studies and applying them to the bedside. It is imperative to identify malnutrition in EGS, both on admission and throughout the duration of the patient's hospital stay, but the current strategies are inadequate. Minimising heterogeneity in study design and patient recruitment will be difficult in this setting given its very nature.

The literature identifies many nutrition screening tools and developing another new tool may not be helpful. It is crucial to emphasise screening and assessment as two distinct pathways. Gaining a better understanding as to how clinicians diagnose and manage malnutrition in EGS practice, and why they use the methods they do, may offer useful insights as to how this process can be made more robust and reproducible. We would recommend that future research in EGS populations should report malnutrition risk at baseline using a recognised tool in order to fully appreciate its impact on outcomes. Standardising this would help with future data synthesis and interpretation.

## Conclusion

There is wide variation in approaches to identify malnutrition risk in EGS patients using a range of tools and nutrition markers, with significant heterogeneity. Reducing variation will permit better understanding of malnutrition risk in surgical patients. Identifying patients that are malnourished, or at risk of being or becoming so, during their admission will allow targeted nutrition intervention and this may improve surgical outcomes. Work is needed to standardise the approach to determining a patient's nutrition status in the EGS setting.

## 4.2 Malnutrition in emergency general surgery: a survey of National Emergency Laparotomy Audit Leads (Paper 2)

### Chapter introduction

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**Ashmore DL**, Wilson T, Halliday V, Lee M. Malnutrition in emergency general surgery: a survey of National Emergency Laparotomy Audit Leads. J Hum Nutr Diet [Internet]. 2024 Mar 4; Available from: <http://dx.doi.org/10.1111/jhn.13293>

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**Timothy R. Wilson:** Supervision; visualization; writing—review and editing.

**Vanessa Halliday:** Methodology; supervision; visualization; writing—review and editing.

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### Supporting appendices

#### Appendix 2

- Additional files to support Paper 2
  - **Additional File 1:** Research governance
  - **Additional File 2:** Ethical approval from University of Sheffield
  - **Additional File 3:** Email invitation
  - **Additional File 4:** Participant Information Sheet
  - **Additional File 5:** Methodology
  - **Additional File 6:** Final instrument
  - **Additional File 7:** Study user interface
- Supplementary tables for Paper 2
  - **Table S8:** Who performs malnutrition screening before, or after, emergency surgery?

- **Table S9:** Reasons why screening or an assessment for malnutrition is not performed every time before or after surgery
- **Table S10:** Screening or assessment methods routinely used to determine malnutrition risk
- **Table S11:** Anthropometric methods routinely used to determine malnutrition risk
- **Table S12:** Biochemical markers routinely used to determine malnutrition risk
- **Table S13:** Body composition tests routinely used to determine malnutrition risk
- **Table S14:** Functional tests routinely used to determine malnutrition risk
- **Table S15:** Does your hospital have a surgical nutrition team/ Nutrition Support Team?
- **Table S16:** Who performs a malnutrition assessment before, or after, emergency surgery?
- **Table S17:** Reasons why a nutrition pathway does not exist pre- or post-operatively
- **Table S18:** Local barriers in identifying malnutrition risk in NELA-eligible EGS patients
- **Table S19:** Correlation of participant responses with laparotomy volume in their hospital
- **Table S20:** Distribution of participants' responses relating to the frequency of screening and assessment for malnutrition pre- and post-operatively in hospitals with a NELA Lead for anaesthetics and surgery
- **Table S21:** Distribution of participants' responses relating to the presence of nutrition pathways pre- and post-operatively if a patient was at risk of malnutrition or malnourished in hospitals with a NELA Lead for anaesthetics and surgery
- **Table S22:** Distribution of participants' responses relating to perceptions regarding overall management of malnutrition risk in NELA-eligible patients in hospitals with a NELA Lead for anaesthetics and surgery
- **Table S23:** Association of participant response according to professional role for hospitals with a NELA Lead for anaesthetics and surgery
- **Table S24:** A summary of the free text comments regarding screening and assessment for malnutrition pre- and post-operatively

## Abstract

### Background and Aims

Patients who are malnourished and have emergency general surgery, such as a laparotomy, have worse outcomes than patients that are not malnourished. It is paramount to identify these patients and minimise this risk. This study aimed to describe current practices in identifying malnutrition in patients undergoing a laparotomy, specifically focussing on screening, assessment, nutrition pathways and barriers encountered by clinicians.

### Methods

Following piloting and validity assessment, anaesthetic and surgical National Emergency Laparotomy Audit (NELA) Leads at hospitals across England and Wales were emailed an invitation to a survey. Responses were gathered using Qualtrics. Descriptive analysis and correlation with laparotomy volume and professional role was performed in SPSSv26. University of Sheffield ethical approval was obtained (UREC 046205). The results from the survey are reported according to the CHERRIES guidelines(199).

### Results

The survey was completed by 166/289 NELA Leads from 117/167 hospitals (57.4% and 70.1% response rates, respectively). Participants reported low rates of nutritional screening (42/166; 25.3%) and assessment (26/166; 15.7%) for malnutrition pre-operatively. More than one third of respondents (40.1%) had no awareness of local screening tools; indeed, the Malnutrition Universal Screening Tool (MUST) was used by approximately half of respondents (56.6%). Contrary to guidelines, NELA Leads report albumin levels continue to be used to determine malnutrition risk (73.5%; 122/166). Post-operative nutrition pathways were common (71.7%; 119/166). Reported barriers to nutritional screening and assessment included a lack of time, training and education, organisational support and ownership. Participants indicated nutrition risk is inadequately identified, and is an important missing data item from NELA. There was no significant correlation with hospital laparotomy volume in relation to screening or assessment for malnutrition, the use of nutritional support pathways, or organisational barriers. There was interprofessional agreement across a number of domains, although some differences did exist.

## **Conclusion**

Wide variation exists in the current practice of identifying malnutrition risk in NELA patients. Barriers include a lack of time, knowledge and ownership. Nutrition pathways that encompass the pre-operative phase and incorporation of nutrition data in NELA may support improvements in care.

## Introduction

There are approximately 22,000 laparotomies annually in England and Wales recorded on the National Emergency Laparotomy Audit (NELA) database(13). NELA is a prospectively-maintained, mandated national database aimed at improving the quality of care for adult (>18 years) patients undergoing emergency laparotomy or laparoscopy for a gastrointestinal (stomach, small or large bowel or rectum) emergency(24). Patients with complications following elective gastrointestinal surgery are also included, however patients with complications following vascular and gynaecological surgery are excluded from the database. Anaesthetic and surgical NELA Leads are consultants of their respective specialty with extensive experience in perioperative decision-making and assessment(299). It is recommended that every hospital in England and Wales has a NELA Lead for anaesthetics and surgery.

Over time, outcomes including mortality rate have improved and the current 30-day mortality rate after emergency laparotomy is 8.7%(13). However, no nutritional data is recorded on the NELA database despite a well-established association between malnutrition and worse outcomes in patients undergoing emergency general surgery (EGS)(7,8,50,300). Malnutrition is also associated with increased healthcare costs(52,53).

A number of national and international bodies have issued guidelines for identifying and managing malnutrition(98,101,106,107), including that all patients should be screened for malnutrition on admission to hospital. Those found to be at risk should have a more focussed assessment and a management plan devised accordingly(54,55). However, a consensus definition for malnutrition is still lacking(301). In addition, many approaches and tools have been described to identify malnutrition. It is not known which method or tool would be most appropriate to use within the context of EGS(302), where assessment may be more challenging due to the complexities of the patients involved and acute context.

## Aims

The aim of this study was to explore current practices in identifying malnutrition in NELA-eligible patients, specifically focussing on screening and assessment, nutrition pathways and barriers encountered. Secondary aims were to explore whether current practice differed according to hospital laparotomy volume or professional role (anaesthetic and surgery NELA Leads) completing the survey.



## Methods

A cross-sectional survey was designed with reference to current nutrition guidelines and the existing literature(43,98,109,112). The survey is provided in Appendix 2. The results from the survey are reported with reference to the CHERRIES guidelines(199).

### Study design

Anaesthetic and surgical NELA Leads are consultants of their respective specialty with extensive experience in perioperative decision-making and assessment(299). It is recommended that every hospital in England and Wales has a NELA Lead who is responsible for overseeing the local audit process. Anaesthetic and surgical NELA Leads for all eligible hospitals that submitted data to NELA's 7<sup>th</sup> report were invited to complete the survey.

This survey was designed to capture limited demographic data about respondents including their main current clinical role and hospital of work. Respondents were asked detailed information regarding perioperative nutrition screening and assessment. This included questions relating to when it is completed, by whom and the methods used to do so. Use of nutrition pathways and barriers encountered were also explored. The following definitions prefixed their respective sections of the survey:

#### *Perioperative Nutrition Screening*

This refers to a process of identifying patients that may have a malnutrition diagnosis and may benefit from an assessment by an appropriately registered healthcare professional.

#### *Perioperative Nutrition Assessment*

This is a systematic and comprehensive process of evaluating nutrition status by an appropriately registered healthcare practitioner. It would confirm a patient's nutrition risk, the likely underlying cause and develop a nutrition management plan. The process of screening followed by a rigorous assessment may not be embedded within every hospital. Consequently, it was made clear that assessment of malnutrition was not dependent on screening for malnutrition having been performed prior, and vice versa.

### Ethical approval and Informed Consent

University of Sheffield ethical approval was obtained (UREC 046205). Potential participants were emailed an invitation to read a Participant Information Sheet which explained the duration of the

survey, data stored, study investigators and purpose of the study. Survey consent was obtained by participants clicking on a link in the invitation email.

### **Development and pre-testing**

The survey was piloted amongst six general surgeons and two anaesthetists involved in EGS at a single teaching hospital in the UK. Face validity was assessed using a 'modified QQ-10'(303). The QQ-10 is a validated tool to assess face validity of patient questionnaires used in healthcare(303). It was modified to account for this research being directed at participants who are healthcare professionals and not patients (Appendix 2). In addition, feedback regarding question wording, survey structure and time taken to complete the survey were gathered.

Responses from the pilot study confirmed appropriate question wording. Free text responses advised the need for clearer explanations regarding definitions for 'screening' and 'assessment', which were incorporated in the revised questionnaire. The modified QQ-10 confirmed the survey was relevant, easy to complete and included all aspects pertinent to the practices and pathways in NELA-eligible patients. The mean time for completion was six minutes.

### **Recruitment and survey administration**

Following refinement, anaesthetic and surgical NELA Leads for all eligible hospitals that submitted data to NELA's 7<sup>th</sup> report(13) were identified and contacted using the details on the freely available NELA Lead database at the time of the study(304), and responses gathered using Qualtrics survey software. Only participants invited to the survey were able to complete it. Where an email returned advising they are no longer the NELA Lead and contact details of the current NELA Lead were provided, the new NELA Lead was contacted using the same process. Hospitals that did not have a NELA Lead for either anaesthetics or surgery were excluded from analysis, as were hospitals that reported fewer than ten laparotomies annually in keeping with NELA's updated outlier policy(305).

The study opened in October 2022 for ten weeks with two additional reminders to complete it. There were no incentives offered. Responses were anonymous. Questions were from a drop-down list, a 5-point Likert with a 'don't know' option, or a selection of options from a menu. Instructions to 'select one' or 'select all that apply' were given as appropriate. Questions were adaptively formatted to understand why an event happens or does not happen, with free text boxes also offered. There were up to five questions per page displayed on 17 pages including the opening and closure pages; a

progress bar was visible. Mandatory questions were indicated and participants were able to review answers.

## **Analysis**

Analyses were performed in IBM SPSSv26. Hospital laparotomy volume was correlated to participant responses using hospital data submitted to NELA's 7<sup>th</sup> report via Spearman's rank correlation. Associations between professional role and participant responses was performed using appropriate tests of significance, namely Mann Whitney U and chi-squared test.

Where multiple responses from a single hospital were obtained, only one response was selected to represent that hospital (Appendix 2). Briefly, responses to five questions were used. 'I do not know' responses were considered less favourable than any other response, and if required, the more positive response between two participants at the same hospital was chosen. Representative statements from free text data are presented in the findings.

## Results

### Survey results

Of the 186 hospitals that submitted data to the NELA 7<sup>th</sup> report, a total of 167 hospitals were contacted. This amounted to contacting hospitals that represented 21,688 laparotomies out of a total of 21,856 (99.2%) laparotomies recorded on the NELA database (ranging from 11 to 364 laparotomies, with a mean of 128 laparotomies per hospital). There were 19 hospitals excluded for submitting fewer than 10 laparotomies per year, being uncontactable, having no active NELA Lead or no longer undertaking EGS at that hospital (

**Figure 4.3**). Of the hospitals excluded for recording fewer than 10 laparotomies per year, this included one hospital that performed five laparotomies, one hospital that performed two laparotomies, and nine hospitals that did not perform any.

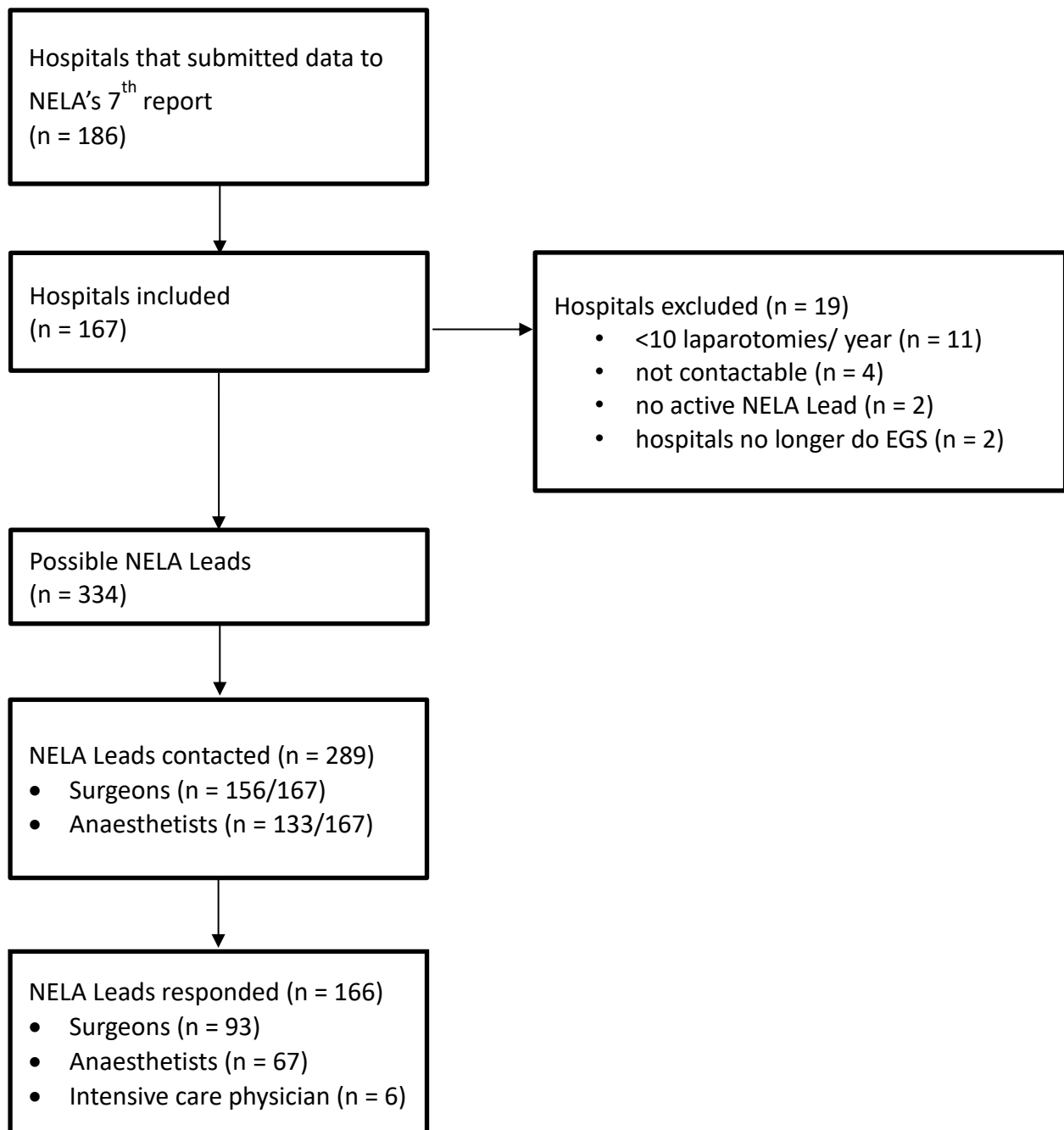


**Figure 4.3:** NELA Lead recruitment

### **Participant completion rate**

A total of 166 responses were obtained from 289 participants, resulting in an overall response rate of 57.4%. The survey was completed by 93 general surgeons, 67 anaesthetists, and 6 intensive care physicians. The responses from anaesthetists and intensive care physicians were pooled for subsequent analysis under the label of 'anaesthetists'.

## Hospital completion rate

Responses from participants (88 surgeons, 26 anaesthetists and four intensive care physicians) at 117/167 (70.1%) hospitals were used to represent hospital-level completion. This accounted for 15,421 laparotomies recorded on the NELA database (ranging from 12 to 364 laparotomies with a mean 132 laparotomies per hospital). There were 45 hospitals with a response from both an anaesthetic and a surgical NELA Lead.

## Perioperative nutrition screening

Screening for malnutrition risk was performed 'regularly' or 'all the time' prior to emergency surgery in only a quarter of cases (42/166) whereas it occurs frequently after emergency surgery (**Table 4.8** and **Figure 4.4**). It is performed pre-operatively by nurses at 56.9% (70/123) and post-operatively by dietitians (27.2%, 85/312) (**Table S8**). A lack of time was the commonest reason for not screening pre-operatively (50.4%, 66/235), but most were not sure why it was not undertaken post-operatively (31.6%, 36/114) (**Table S9**).

The Malnutrition Universal Screening Tool (MUST) was the screening tool of choice although 40.1% (68/166) of respondents did not know which tool was used (**Table S10**). Albumin was the commonest marker for malnutrition used by 73.5% (122/166) anaesthetists and surgeons fairly equally, followed by body mass index (58.4%, 97/166) and a weight history (55.4%, 92/166) (**Table S11**, **Table S12**). Other body composition and functional methods are rarely used (**Table S13**, **Table S14**).

## Perioperative nutrition assessment

Nutrition Support Teams (NST) were present in hospitals according to 82.8% (77/93) of surgical NELA Leads (**Table S15**). Almost half of participants responded that an assessment of nutritional status was 'never' or 'rarely' performed prior to surgery (45.1%, 75/166), but was undertaken 'regularly' or 'all the time' after surgery (49.4%, 82/166) (**Table 4.8** and **Figure 4.4**). When an assessment was performed prior to EGS, it was done so by general surgeons (23.8%) and dietitians (22.3%) (**Table S16**). Post-operatively it was performed by dietitians in most cases (32.8%, 100/305) (**Table S16**). A quarter of surgeons did not think an assessment of nutritional status would change immediate management pre-operatively (24.5%, 35/143), although again a lack of time was the main reason for this not being performed (29.6%, 61/206). A lack of access to an appropriate person was the main barrier post-operatively (36.4%, 44/121) (**Table S9**).

**Table 4.8:** Distribution of all participants' responses relating to the frequency of screening and assessment for malnutrition pre- and post-operatively

| Question                                                    | Role | Never     | Rarely    | Occasionally | Regularly | All the time | Don't know |
|-------------------------------------------------------------|------|-----------|-----------|--------------|-----------|--------------|------------|
| <b>Screening for malnutrition before emergency surgery</b>  | A    | 15.1 (11) | 31.5 (23) | 16.4 (12)    | 6.8 (5)   | 1.4 (1)      | 28.8 (21)  |
|                                                             | S    | 7.5 (7)   | 24.7 (23) | 24.7 (23)    | 29.0 (27) | 9.7 (9)      | 4.3 (4)    |
|                                                             | T    | 10.8 (18) | 27.7 (46) | 21.1 (35)    | 19.3 (32) | 6.0 (10)     | 15.1 (25)  |
| <b>Screening for malnutrition after emergency surgery</b>   | A    | 0 (0)     | 6.8 (5)   | 8.2 (6)      | 24.7 (18) | 6.8 (5)      | 53.4 (39)  |
|                                                             | S    | 0 (0)     | 7.5 (7)   | 11.8 (11)    | 52.7 (49) | 25.8 (24)    | 2.2 (2)    |
|                                                             | T    | 0 (0)     | 7.2 (12)  | 10.1 (17)    | 40.4 (67) | 17.5 (29)    | 24.7 (41)  |
| <b>Assessment for malnutrition before emergency surgery</b> | A    | 11.0 (8)  | 23.3 (17) | 9.6 (7)      | 4.1 (3)   | 1.4 (1)      | 50.7 (37)  |
|                                                             | S    | 11.8 (11) | 41.9 (39) | 20.4 (19)    | 20.4 (19) | 3.2 (3)      | 2.2 (2)    |
|                                                             | T    | 11.4 (19) | 33.7 (56) | 15.7 (26)    | 13.3 (22) | 2.4 (4)      | 23.5 (39)  |
| <b>Assessment for malnutrition after emergency surgery</b>  | A    | 1.4 (1)   | 4.1 (3)   | 13.7 (10)    | 19.2 (14) | 5.5 (4)      | 56.2 (41)  |
|                                                             | S    | 0 (0)     | 11.8 (11) | 16.1 (15)    | 46.2 (43) | 22.6 (21)    | 3.2 (3)    |
|                                                             | T    | 0.6 (1)   | 8.4 (14)  | 15.1 (25)    | 34.3 (57) | 15.1 (25)    | 26.5 (44)  |

Responses as % (n). Abbreviations: Anaesthetists (A); surgeons (S); total (T).

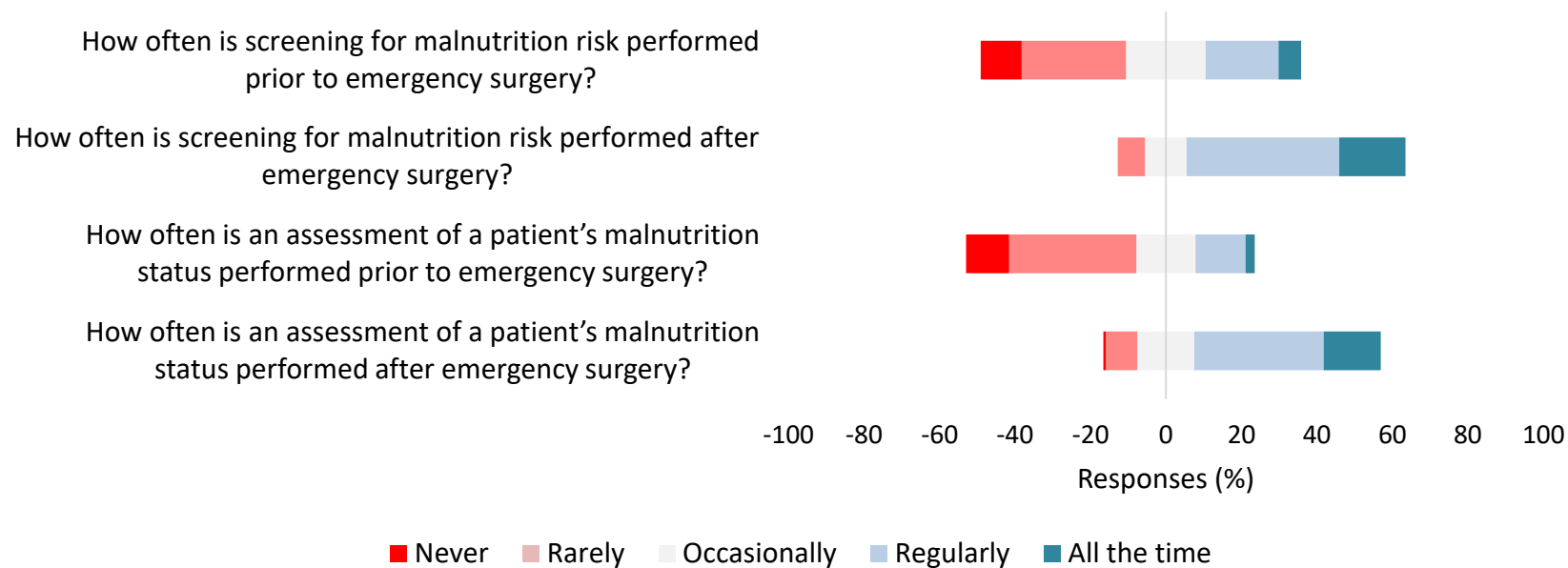


**Figure 4.4:** Distribution of all responses from surgeons and anaesthetists relating to frequency of screening and assessment for malnutrition pre- and post-operatively



## Management of patients identified at risk of malnutrition or malnourished

If a patient was identified as at risk of malnutrition or malnourished, two-thirds of participants indicated there was not a pathway to provide nutritional support pre-operatively (63.3%, 105/166). However, three-quarters of participants indicated there was a pathway post-operatively (71.7%, 119/166) (**Table 4.9**). Where participants indicated a pathway did not exist, the majority did not know why this was the case pre- (37.3%, 47/126) or post-operatively (57.7%, 30/52) (**Table S17**). Very few participants indicated it would be because implementing nutritional support would not improve patient outcomes either pre-operatively (4.8%, 6/126) or post-operatively (1.9%, 1/52) (**Table S17**).

**Table 4.9:** Distribution of all participants' responses relating to the presence of nutrition pathways pre- and post-operatively if a patient was at risk of malnutrition or malnourished

| Question                                                | Role | Yes        | No         |
|---------------------------------------------------------|------|------------|------------|
| Pathway to provide nutritional support pre-operatively  | A    | 26.0 (19)  | 74.0 (54)  |
|                                                         | S    | 45.2 (42)  | 54.8 (51)  |
|                                                         | T    | 36.7 (61)  | 63.3 (105) |
| Pathway to provide nutritional support post-operatively | A    | 61.6 (45)  | 38.4 (28)  |
|                                                         | S    | 79.6 (74)  | 20.4 (19)  |
|                                                         | T    | 71.7 (119) | 28.3 (47)  |

Responses as % (n). Abbreviations: Anaesthetists (A); surgeons (S); total (T).

## Organisational barriers

Participants were specifically asked to indicate what the local difficulties or barriers were in identifying malnutrition risk in this high-risk surgical group. A lack of time in the emergency setting was the commonest reason (23.1% 71/307) (**Figure 4.5, Table S18**). However, a lack of training and education (18.2%, 56/307) followed equally by a lack of organisational support and clarity regarding who is responsible for managing peri-operative malnutrition (16.3%, 50/307) were indicated.

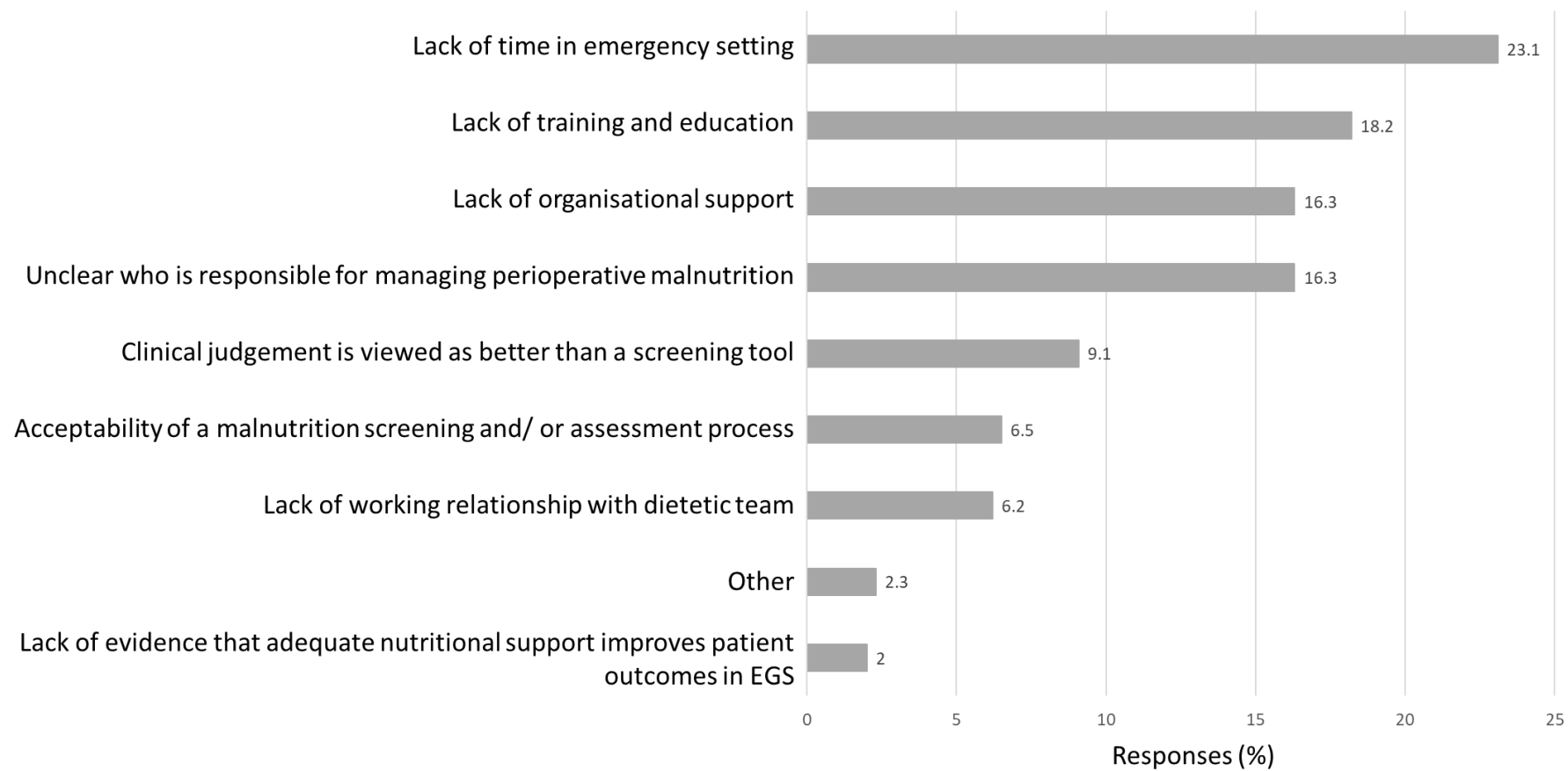


**Figure 4.5:** Local barriers in identifying malnutrition risk in NELA-eligible EGS patients

### **Perceptions regarding overall management**

Only 1 in 5 participants (32/166) agree or strongly agree that malnutrition risk is adequately identified in NELA-eligible patients pre-operatively (**Table 4.10** and **Figure 4.6**), and this remains less than half post-operatively (45.1%, 75/166). Again, fewer than half of participants had the confidence their team identify and manage EGS patients with malnutrition (48.8%, 81/166). However, a majority of participants indicated that it would be beneficial to have a standard pathway for identifying and managing perioperative malnutrition as it might improve patient outcomes (83.7%, 139/166). A similarly positive response indicated that it would be beneficial to include malnutrition risk as part of the NELA data collection process (71.1%, 118/166) (**Table 4.10** and **Figure 4.6**).

**Table 4.10:** Distribution of all participants' responses relating to perceptions of overall management of malnutrition risk in NELA-eligible patients

| Question                                                                                                                                                    | Role | Strongly disagree | Disagree  | Neither agree nor disagree | Agree     | Strongly agree |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------|-----------|----------------------------|-----------|----------------|
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients pre-operatively                                                  | A    | 16.4 (12)         | 49.3 (36) | 20.5 (15)                  | 9.6 (7)   | 4.1 (3)        |
|                                                                                                                                                             | S    | 15.1 (14)         | 36.6 (34) | 24.7 (23)                  | 20.4 (19) | 3.2 (3)        |
|                                                                                                                                                             | T    | 15.7 (26)         | 42.2 (70) | 22.9 (38)                  | 15.7 (26) | 3.6 (6)        |
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients postoperatively.                                                 | A    | 6.8 (5)           | 34.2 (25) | 38.4 (28)                  | 15.1 (11) | 5.5 (4)        |
|                                                                                                                                                             | S    | 4.3 (4)           | 16.1 (15) | 15.1 (14)                  | 51.6 (48) | 12.9 (12)      |
|                                                                                                                                                             | T    | 5.4 (9)           | 24.1 (40) | 25.3 (42)                  | 35.5 (59) | 9.6 (16)       |
| I am confident that my team is able to identify and manage emergency general surgical patients with malnutrition.                                           | A    | 6.8 (5)           | 21.9 (16) | 39.7 (29)                  | 27.4 (20) | 4.1 (3)        |
|                                                                                                                                                             | S    | 2.2 (2)           | 10.8 (10) | 24.7 (23)                  | 51.6 (48) | 10.8 (10)      |
|                                                                                                                                                             | T    | 4.2 (7)           | 15.7 (26) | 31.3 (52)                  | 41.0 (68) | 7.8 (13)       |
| It would be beneficial to have a standard protocol or pathway for identifying and managing perioperative malnutrition as it might improve patient outcomes. | A    | 1.4 (1)           | 2.7 (2)   | 9.6 (7)                    | 49.3 (36) | 37.0 (27)      |
|                                                                                                                                                             | S    | 3.2 (3)           | 3.2 (3)   | 11.8 (11)                  | 52.7 (49) | 29.0 (27)      |
|                                                                                                                                                             | T    | 2.4 (4)           | 3.0 (5)   | 10.8 (18)                  | 51.2 (85) | 32.5 (54)      |
| It would be beneficial to include malnutrition risk as part of the NELA data collection process.                                                            | A    | 5.5 (4)           | 9.6 (7)   | 17.8 (13)                  | 37.0 (27) | 30.1 (22)      |
|                                                                                                                                                             | S    | 4.3 (4)           | 7.5 (7)   | 14.0 (13)                  | 45.2 (42) | 29.0 (27)      |
|                                                                                                                                                             | T    | 4.8 (8)           | 8.4 (14)  | 15.7 (26)                  | 41.6 (69) | 29.5 (49)      |

Responses as % (n). Abbreviations: Anaesthetists (A); surgeons (S); total (T).

### Correlation with laparotomy volume

There was a weak negative correlation in perceived adequacy of identifying malnutrition risk in NELA-eligible patients pre-operatively and laparotomy volume (Spearman's Rank correlation,  $r = -0.19$ , (-0.360, -0.007;  $p = 0.042$ )) (Table S19). However, there was no significant correlation with hospital laparotomy volume across any other domain including screening, or assessment for malnutrition, the use of nutritional support pathways, or organisational barriers (Table S19).

### Association with professional role

Data for hospitals whereby both an anaesthetic and surgical NELA Lead submitted a response are shown (Table S20, Table S21, Table S22, Table S23). Participant response did not vary according to professional role for how often an assessment for malnutrition occurs, the overall perception of how adequate malnutrition risk is identified pre-operatively or the perceived benefit of including malnutrition risk as part of the NELA collection process (Table S23). However, differences were evident

regarding: how often screening for malnutrition occurs before ( $n = 76$ ,  $p = 0.027$ ) and after ( $n = 65$ ,  $p = 0.029$ ) surgery; the presence of a pathway for nutritional support before ( $n = 90$ ,  $p = 0.004$ ) and after ( $n = 90$ ,  $p = 0.020$ ) surgery; perceptions regarding adequacy of malnutrition identification post-operatively ( $n = 90$ ,  $p = <0.001$ ); and, confidence that the team can identify and manage EGS patients with malnutrition ( $n = 90$ ,  $p = <0.001$ ).

### **Free text comments**

A summary of the free text comments with respect to nutrition screening and assessment pre- and post-operatively are described (**Table S24**). Comments regarding other barriers in identifying malnutrition risk relate to a lack of awareness, access out of hours, financial resources and overall workload.

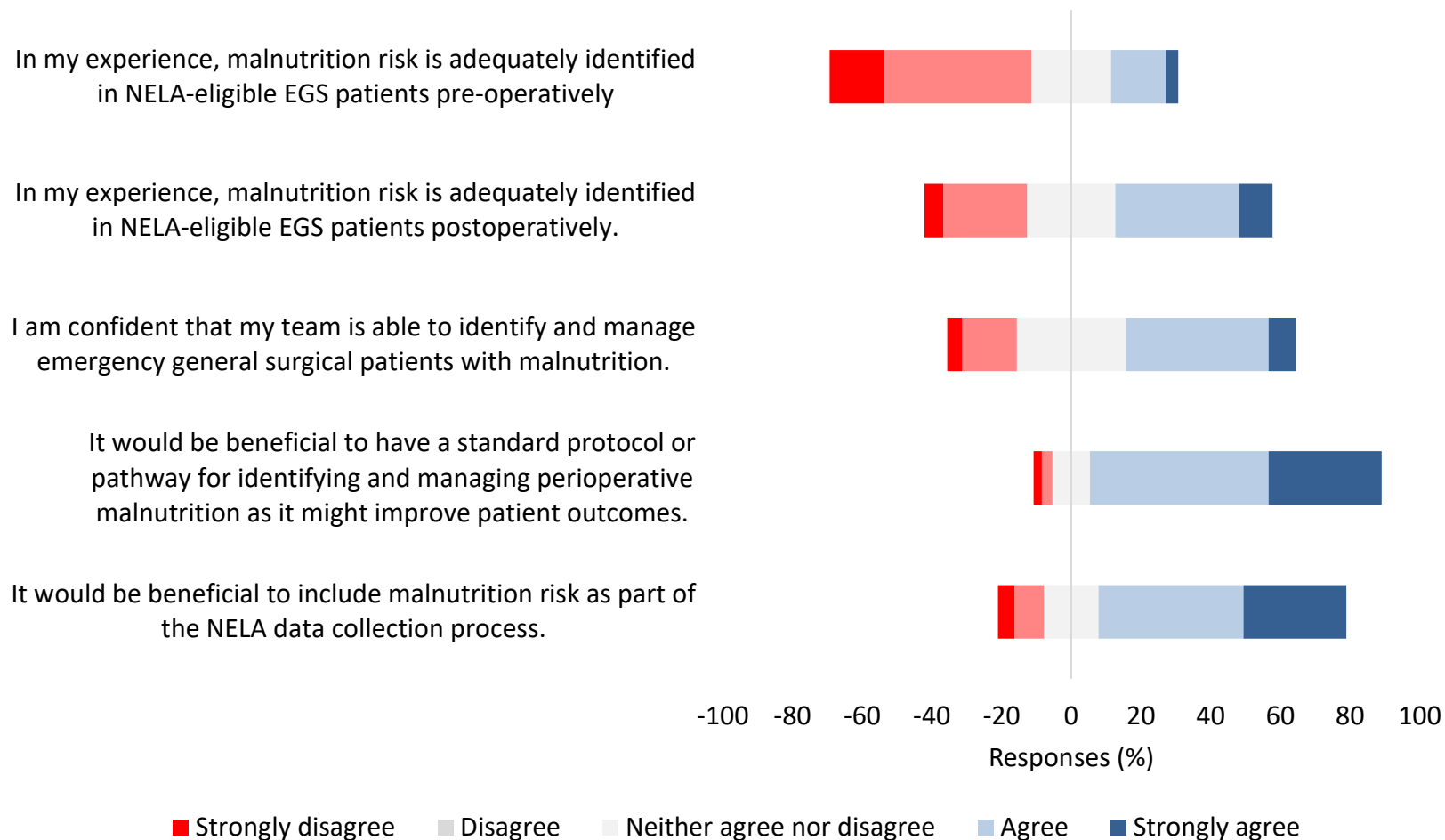


**Figure 4.6:** Distribution of responses relating to perceptions in the overall management of malnutrition risk in NELA-eligible patients

## Discussion

This national survey of NELA Leads in England and Wales reports considerable variation of current practices in relation to screening and assessment of malnutrition in NELA-eligible patients.

Screening is a process of identifying patients that may have a diagnosis of malnutrition. All patients should be screened for malnutrition on admission to hospital and weekly thereafter in the UK(98). Similar to other studies, only a quarter of participants responded that routine screening for malnutrition is performed prior to surgery(306). Participants may not have been aware that it has been performed, or may not use it in any subsequent decision-making process, as it is typically considered a task undertaken by nurses. Additionally, the outcome of the nutrition screening may not be readily available to clinicians for various reasons during the decision-making process, and this may affect the answers provided in this study. Although it is surprising 40.1% of participants did not know which screening tool was used in their hospital, the Malnutrition Universal Screening Tool (MUST) is the most commonly used and is currently recommended by NICE(98).

MUST has been validated in many populations and settings(75). A score of 2 or more indicates a patient is at high risk of being malnourished and this should trigger a referral to the dietitian or the NST for an assessment. This study identified that although NSTs are recommended, they are not ubiquitous, similar to previous findings(15,154). NELA-eligible patients may be high risk due to the acute nature of their disease and absence of any nutritional intake for more than five days(302); MUST may not be appropriate in this cohort. An alternative to screening is to refer all patients to the dietetic service or NST for an assessment, however this would likely be beyond workforce capacity. Although MUST was not originally validated in NELA patients, higher scores have since been shown to correlate with time without enteral nutrition(302).

Patients not screened for malnutrition may not be referred for an assessment in a timely manner. We know there is a delay in referring patients for consideration of nutritional support(307). This may explain why fewer-than-expected participants reported nutritional assessments are undertaken routinely, particularly pre-operatively. A lack of time, access, training, and perception that it does not alter the immediate management, were common reasons why screening or an assessment were not performed.

Albumin was the most used marker of malnutrition by 73.5% of participants, despite national and international guidelines advising the contrary(43,98–101). Although albumin does correlate with surgical outcomes and is collected on the NELA database for this reason, it reflects the acute disease and inflammation rather than malnutrition. It is not recommended to be used as such(100,308). Patients with a normal albumin may still have severe malnutrition resulting in terrible outcomes; relying on this blood test as a marker of malnutrition in the acute setting is ill advised.

Participants also frequently used body mass index and a weight history to identify malnutrition. These can be difficult to ascertain objectively in the EGS setting, yet often constitute a criterion in screening tools such as MUST. The increase in global obesity may also potentially reduce the usefulness of these markers. The presence of hidden micronutrient deficiencies in this population is well described. More research is required to understand the impact of obesity on surgical management and outcomes in this context(105,308).

Interestingly, body composition and functional methods were rarely reportedly used to identify malnutrition, nor were computerised tomography (CT) scans, yet more than 90% of patients undergo a pre-operative CT scan according to NELA data(13,16). Measuring reduced muscle mass using CT is one criterion for a diagnosis of malnutrition using the Global Leadership in Malnutrition (GLIM), guidelines which are recommended internationally(101). Additionally, studies have shown that measuring sarcopenia via CT is a valid method in EGS patients, and that sarcopenic patients have a one-year mortality rate of 57% after emergency laparotomy(309). The use of routine CT imaging to inform decision making requires further research and incorporation into a screening tool may be warranted.

This study highlighted several common barriers in identifying malnutrition in NELA patients. A lack of time in the EGS setting was expected. Interestingly however, others included a lack of training and education, a lack of organisational support and it being unclear who's responsibility it is to manage perioperative nutrition. This will require more systemic and cultural changes. Whilst identifying malnutrition in all patients admitted to hospital is every clinician's responsibility, there needs to be clear processes to ensure this is done and acted on effectively. The vast majority (83%) of participants believe 'nutrition pathways' may improve patient outcomes, yet in the mainstay these do not exist pre-operatively. This reflects findings mirrored in operatively-managed patients with small bowel obstruction, whereby nutritional support is more likely to be considered post-operatively than pre-operatively(310). A small number of



'early recovery pathways' have been implemented with difficulty in EGS(42,311). These have been associated with reduced mortality, although not specifically due to optimising nutritional care(312). Linking a patient's malnutrition status to their NELA outcomes may be a way to do this, and participants indicated support for this additional data collection.

Differences in variation of screening and assessment of malnutrition within NELA-eligible patients is not related to hospital laparotomy volume. Only one participant response was selected to represent a hospital where multiple responses had been received, and this may have introduced selection bias. Case volume has previously been shown not to correlate with dietitian review or use of parenteral nutrition(50,312–314).

Associations between participant responses and professional subtype were also analysed. Key differences pertained to frequency of screening, the presence of nutritional pathways and perceptions related to the adequacy of identifying, and confidence with managing, malnutrition. Anaesthetists are typically only involved with EGS patients in the perioperative period only and this may explain these differences.

## **Strengths of the study**

This national study benefits from comparatively high completion rates at both a clinician- and hospital-level, which are higher than similar studies(306,313–315). It was piloted locally, included both anaesthetic and surgical NELA Leads and correlated responses with contemporaneous hospital laparotomy volume.

## **Limitations of the study**

However, this study is not without limitations. Firstly, screening and assessment of malnutrition is a dynamic process that should continue throughout a patient's admission. Whilst not captured in this study, reassessment is likely to represent a smaller proportion of those patients that are screened and assessed initially. Secondly, this study was focussed on perioperative nutrition for NELA-eligible patients. However, there will be other high risk EGS groups that are malnourished or at risk of being malnourished and not captured on the NELA database, for example non-operatively managed patients with small bowel obstruction(302) or acute pancreatitis. Thirdly, the detail of nutrition pathways were not assessed as it was beyond the remit of the study. There may be a role for developing a national pathway for this patient cohort which incorporates current guidelines.

Given the variation in practice, and relative blind spot in current care and audit, policy makers might consider the inclusion of nutritional status in routine datasets such as NELA; our study showed this had wide support. This would allow correlations with outcomes at a population level. Professional associations should consider the highlighted issues regarding awareness and education of nutritional management of the EGS patient. Educational materials should be provided to aid this, and consideration should be given to roles for dietitians in the acute surgical setting to support best practice.

Researchers should consider the limited awareness and expert skills in the EGS setting when designing research on the topic. Feasibility work may be needed to ensure any proposed intervention is deliverable. Qualitative research exploring clinicians' understanding of who is malnourished, why this is the case, when to intervene and how this changes surgical management are future research areas.

## Conclusion

This study shows variation in current practices of identifying malnutrition within NELA-eligible patients. Several barriers exist and include a lack of time, training and education, access and ownership of the problem. Future directions include developing consensus 'nutrition pathways', routine data linkage to enable correlation with patient outcomes, and exploring the process around clinicians' decision making.

## Chapter summary

### Paper 1

- The systematic review is based on the manuscript published in the British Journal of Surgery Open. It aimed to describe how malnutrition is identified in EGS, with a focus on nutrition screening and assessment tools, their components, as well as other markers of malnutrition.
- There were 7,243 records identified in searches, from which 324 reports were retrieved and assessed for eligibility. Of these, 31 studies were included. There were only three multicentre, prospective studies included.
- Nutritional status was defined in 75% of studies and can be mapped to six 'core areas' including history, clinical examination, blood (laboratory) values, disease criteria, formulae and functional tests.
- There were seven nutrition screening tools or methods in use, with no tool dominating the landscape.
- There were nine nutrition assessment tools, of which the most used was the Subjective Global Assessment (SGA) tool.
- A plethora of alternate nutrition markers were used. There were seven single nutrition markers, and seven combined measures used to define malnutrition. Overall, BMI was the most used criteria to define malnutrition as either a primary or secondary marker of nutritional status, or as a key component of a nutritional tool, in 64.5% (n = 20) studies. Serum albumin was used as the same in 58.1% (n = 18) studies.

### Paper 2

- The survey was based on the manuscript published in the Journal of Human Nutrition and Dietetics. It aimed to describe current practices in identifying malnutrition in NELA-eligible patients. Secondary aims were to explore whether current practice differed according to hospital laparotomy volume or professional role of participants completing the survey.
- A total of 166/289 participants (57.4%), of which 93 were general surgeons, completed the survey. A total of 117/167 (70.1%) hospitals were used to represent hospital-level completion.
- This study shows variation in current practices of identifying malnutrition within NELA-eligible patients, with limited awareness of nutritional screening tools used locally. The Malnutrition Universal Screening Tool (MUST) was most commonly used, but many participants reported using albumin to regularly determine malnutrition risk.

- Malnutrition risk through screening or assessment was not performed commonly pre-operatively, but is performed more commonly post-operatively. Participants felt it beneficial to develop a standard pathway for this and to include malnutrition risk as part of NELA data collection.
- A range of barriers to identifying malnutrition risk were highlighted, including a lack of time, training and education, organisation support and ownership of the issue. Only 2% of participants considered there to be a lack of evidence that adequate nutritional support improves outcomes in EGS.
- Hospital laparotomy volume did not correlate with nutritional screening or assessment practices, the use of nutritional support pathways, or organisational barriers.

## 5 Research question 2: If there are differences in how surgeons identify malnutrition in emergency general surgery, why do they exist?

This chapter presents three papers which aim to answer this research question. Paper 3 is a qualitative study of 18 consultant surgeons that undertake EGS using semi-structured interviews. It dives deep into how and why surgeons identify malnourished EGS patients, focussing on barriers encountered. It explored whether practice is related to different institutional settings.

Paper 4 is a cross-sectional survey of consultants and non-consultants (trainees and non-trainee surgeons) and describes how nutritional status is determined according to surgeon seniority and experience of intestinal failure. It also explores how surgeons were trained in identifying malnutrition, a lack of which was a common theme from the interviews.

Paper 5 is a discrete choice experiment. It used 25 hypothetical scenarios to determine the influence of six variables on whether surgeons would start nutritional support, and investigated whether this was related to surgeon seniority or experience of intestinal failure.

Objectives addressed in this chapter are:

- **Objective 3:** To explore how consultants that undertake EGS identify malnutrition and the barriers they encounter.
- **Objective 4:** To establish how senior decision makers identify malnutrition in EGS, how they were trained and how it may be improved.
- **Objective 5:** To determine the impact of key variables on senior decision makers' treatment preferences to start nutritional support for EGS patients.
- **Objective 6:** To understand if surgeon seniority or experience of intestinal failure influences surgeon decision making regarding starting nutritional support.

## 5.1 Barriers faced by surgeons in identifying and managing malnutrition in emergency general surgery: a qualitative study (Paper 3)

### Chapter introduction

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**Ashmore DL**, Baker D, Wilson TR, Halliday V, Lee MJ. Barriers Faced by Surgeons in Identifying and Managing Malnutrition in Emergency General Surgery: A Qualitative Study. Colorectal Disease: The Official Journal of the Association of Coloproctology of Great Britain and Ireland. 2024 Dec 10; Available from: <https://doi.org/10.1111/codi.17261>.

### Author Contributions

- **Daniel Ashmore:** Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Visualization; Writing - original draft; Writing - review & editing.
- **Daniel Baker:** Formal analysis; Validation; Visualization; Writing - review & editing
- **Timothy Wilson:** Supervision; Visualization; Writing - review & editing
- **Vanessa Halliday:** Conceptualization; Methodology; Supervision; Visualization; Writing - review & editing
- **Matthew Lee:** Conceptualization; Methodology; Supervision; Visualization; Writing - review & editing

### Supporting appendices

#### Appendix 3

- Additional files to support Paper 3
  - **Additional File 1:** Research governance

- **Additional File 2:** Ethical approval from University of Sheffield
- **Additional File 3:** Support from the Association of Surgeons of Great Britain and Ireland (ASGBI)
- **Additional File 4:** Extension of support from the Association of Surgeons of Great Britain and Ireland (ASGBI)
- **Additional File 5:** Participant invitation email
- **Additional File 6:** Participant Information Sheet
- **Additional File 7:** Written consent form
- **Additional File 8:** Methodology
- **Additional File 9:** Interview schedule
- **Additional File 10:** Framework development
- **Additional File 11:** Additional results for Paper 3
- **Supplementary tables for Paper 3**
  - **Table S25:** Illustrative quotes related to how surgeons identify malnutrition
  - **Table S26:** Illustrative quotes related to barriers encountered by surgeons
  - **Table S27:** Illustrative quotes related to clinical decision making by surgeons

## Abstract

### Background and aims

Many patients undergoing emergency surgery are malnourished. Identifying malnutrition is a prerequisite to offering targeted nutritional support. Guidelines exist but little is known regarding exactly how surgeons identify malnutrition, or the barriers that influence surgeons' clinical decision making. This study aimed to explore how consultant surgeons identify malnutrition in emergency general surgery (EGS) patients and the barriers to nutritional assessment and intervention.

### Methods

Consultant surgeons with emergency surgery duties were invited to participate. Semi-structured interviews were conducted online, audio-visually recorded and transcribed. An inductive approach was used for data analysis using the Framework Method. Coding and analysis were performed by two independent researchers using NVivo software. Themes were developed and reviewed with the supervising team. Interviews continued until data saturation was reached. Ethical approval was gained prior to interviews.

### Results

Eighteen interviews were conducted across three hospital settings. Identification of malnutrition consisted of three themes: 'The Surgeon' (knowledge, experience, planning ahead); 'The Patient' (selection, composition, clinical progress, operative considerations); and 'The Institution' (collaboration, extended surgical team). Three themes encompassed barriers experienced: 'The Surgeon' (understanding, culture, ownership, time constraints); 'The Institution' (provision, staffing, conflict, hospital setting); and 'The Wider Context' (research, external factors). These influenced clinical decision making, which had two themes; 'To join or not to join' (risk taking, site of anastomosis) and 'Nutritional support' (timing, referral pathways).

### Conclusion

The identification and management of malnutrition in EGS is fraught with barriers, impacting operative and clinical decision making. Improvements in surgeon education, culture, collaborative working, and resource are needed.



## Introduction

Malnourished patients have worse surgical outcomes(8,47,50) compared to well-nourished patients. As many as 60 percent of patients who undergo emergency general surgery (EGS) are malnourished(8,48). No consensus definition of malnutrition exists, with a recent systematic review demonstrating a wide variety of methods used in the EGS literature(301).

Wide variation in practice and several contextual barriers hinder senior decision-makers identifying malnutrition in EGS patients(316). Identifying and managing malnourished EGS patients is a dynamic process. Clinical guidelines exist with a range of screening tools, assessment processes and recommendations(43,98–101). However, challenges persist such that the commencement of nutritional support is delayed(302,307). This 'delay' may reflect a complex decision-making process as a result of several barriers encountered by surgeons(316). However, no research explores why this is so, or the presence and reason for other barriers that may also exist in complex healthcare systems.

## Aims

This study explored this theory further with our aims being to (1) understand how consultant surgeons identify malnutrition; (2) explore barriers that exist; and, (3) identify whether this practice is reflected across different institutional settings.

## Methods

### Overview of study design

The design and reporting of this explorative qualitative study is in accordance with guidelines(228). Written, informed consent was obtained from participants. Ethical approval was received from the University of Sheffield, UK (UREC 050436).

### Research team and reflexivity

Interviews were carried out by DA (PhD student/ surgical trainee) following formal training. A summary of the research team's role and experience is provided (Table S1). Reflexivity has many definitions(317), and was addressed in several ways throughout this study (Table S2).

### Methodological approach

Wide variation in practice and several contextual barriers hinder senior decision-makers identifying malnutrition in EGS patients(316). However, no research explores why this is so, or the presence and reason for other barriers that may also exist in complex healthcare systems. An exploratory approach with semi-structured interviews was chosen to answer these questions with senior surgical decision-makers.

An inductive approach was used for data analysis using the Framework Method, a type of thematic analysis(220,221). This approach is widely used in healthcare research and uses a systematic process. Semi-structured interviews allow researchers to explore ideas with deeper questioning, whilst guiding the interview along a common framework. It can help draw conclusions around themes according to individuals, or specific groups or organisations(221), including different hospital settings as in this study.

### Participant selection

Eligible participants were UK consultant surgeons that undertook EGS. Participants were purposively selected to ensure broad representation of EGS experience/practice with respect to sex, years qualified, and hospital setting. These included district general hospitals (DGH), teaching hospitals (TH) and intestinal failure units (IFU). Forty-eight EGS surgeons were contacted directly having registered an interest in previous studies conducted by the research team, of which nine responded and were interviewed. Additional recruitment was via social media platforms to EGS specific groups and relevant clinical specialty associations. Potential participants who had expressed interest were given the

participant information sheet and interviews arranged for those willing to take part at a mutually convenient time. Electronic signed consent with verbal confirmation at the start of the interview was obtained.

## **Data collection**

Interviews were conducted online using Google Meet™ video conference system (Google, Palo Alto, CA) using the pre-developed interview schedule (Supplementary Information). Only DA and the participant were present. The interview schedule was prepared by DA, ML, and VH (Appendix 3). Each interview began with a background to the study, after which open-ended questions were used to build rapport. Descriptors of participant years qualified, current hospital setting and previous intestinal failure (IF) experience were recorded. The process of delivering nutrition was avoided unless this had subsequently changed their practice in how they identify malnutrition. Additional questions were asked as needed or to follow up important points. Interviews were audio-visually recorded, performed once only, and were anticipated to last no longer than one hour. Supporting field notes were taken and informed interview schedule development to explore emerging themes and issues related to reflexivity.

## **Data analysis and coding**

Interviews were transcribed by DA. Transcripts were not returned to participants. Themes were identified using well-described methods(220). Coding was undertaken by DA for all transcripts using NVIVO v11(318). Half of transcripts underwent dual review and coding, with development of a thematic framework between DA and DB, and agreement from the research team. Participants did not provide feedback on the findings. Data saturation was reviewed following twelve interviews, after which it has previously been shown to occur(319). ‘Meaning saturation’ can require at least 16 interviews(320). Interviews were performed until data saturation with no new themes identified.

## Results

Eighteen interviews were conducted across three hospital settings. All surgeons worked in different units, except the four intestinal failure unit surgeons, who worked across two organisations. Fourteen surgeons were male. Surgeon experience ranged from six months to 23 years (mean 7.5 years). Mean interview length was 44 minutes (range 26-58 minutes). A summary of participant characteristics is provided (**Table 5.1**).

**Table 5.1:** Participant characteristics

| Participant | Sex | Years as a consultant | Hospital setting       | Experience with intestinal failure | Primary clinical subspecialty |
|-------------|-----|-----------------------|------------------------|------------------------------------|-------------------------------|
| 1           | M   | 10.5                  | Teaching               | Yes                                | UGI OG                        |
| 2           | F   | 5                     | Teaching               | No                                 | EGS & major trauma            |
| 3           | M   | 10                    | DGH                    | No                                 | EGS                           |
| 4           | M   | 2.5                   | Teaching               | No                                 | EGS                           |
| 5           | M   | 6.5                   | Teaching               | No                                 | EGS                           |
| 6           | M   | 13                    | Teaching               | Yes                                | Colorectal                    |
| 7           | F   | 4                     | Teaching               | No                                 | EGS & major trauma            |
| 8           | M   | 4                     | Teaching               | No                                 | Colorectal & EGS              |
| 9           | M   | 9                     | Teaching               | Yes                                | HPB & EGS                     |
| 10          | F   | 0.5                   | Teaching               | No                                 | Colorectal                    |
| 11          | M   | 17                    | IF unit 1 <sup>a</sup> | Yes                                | Colorectal & IF               |
| 12          | M   | 2.5                   | Teaching               | No                                 | UGI & bariatrics              |
| 13          | M   | 6                     | DGH                    | No                                 | UGI                           |
| 14          | M   | 4                     | IF unit 1 <sup>a</sup> | Yes                                | Colorectal & IF               |
| 15          | M   | 23                    | DGH                    | No                                 | UGI                           |
| 16          | M   | 4                     | IF unit 2 <sup>b</sup> | Yes                                | Colorectal & IF               |
| 17          | F   | 3.5                   | IF unit 2 <sup>b</sup> | Yes                                | Colorectal & EGS              |
| 18          | M   | 10                    | DGH                    | No                                 | Colorectal                    |

Experience with IF includes time as a trainee/ fellow roles. <sup>a,b</sup>Participants from the same hospital setting. Abbreviations: male (M); female (F); district general hospital (DGH); intestinal failure (IF); emergency general surgery (EGS); upper gastrointestinal (UGI); oesophago-gastric (OG).

## Final Thematic Framework

The final thematic framework is provided along with an indication of data saturation (**Table 5.2**). Analysis of the data relating to the identification of malnutrition revealed three overarching themes: ‘The Surgeon’, ‘The Patient’ and ‘The Institution’ (**Table S25**). The data pertaining to barriers also yielded three themes: ‘The Surgeon’, ‘The Institution’ and ‘The Wider Context’ (**Table S26**). These influenced clinical decision making. It had two themes: ‘To join or not to join’ and ‘Nutritional support’ (**Table S27**). These themes and subthemes are illustrated (**Figure 5.1**).

This manuscript specifically presents results focussing on the barriers experienced by surgeons, however illustrative quotes are provided for all themes and subthemes (**Table S25**, **Table S26** and **Table S27**). We then draw together all themes in our discussion, identifying areas that may offer the greatest opportunity to implement change and improve outcomes for patients.

**Table 5.2:** Final thematic framework with data saturation of subthemes

| Themes                                    | Subthemes                     | Number of participants referencing subtheme, n (%) |
|-------------------------------------------|-------------------------------|----------------------------------------------------|
| <b>How surgeons identify malnutrition</b> |                               |                                                    |
| <b>The Surgeon</b>                        | <i>Knowledge</i>              | 18 (100.0)                                         |
|                                           | <i>Experience</i>             | 14 (77.8)                                          |
|                                           | <i>Planning ahead</i>         | 7 (38.9)                                           |
| <b>The Patient</b>                        | <i>Selection</i>              | 18 (100.0)                                         |
|                                           | <i>Composition</i>            | 17 (94.4)                                          |
|                                           | <i>Clinical progress</i>      | 4 (22.2)                                           |
|                                           | <i>Operative strategy</i>     | 18 (100.0)                                         |
| <b>The Institution</b>                    | <i>Collaboration</i>          | 12 (66.7)                                          |
|                                           | <i>Extended surgical team</i> | 5 (27.8)                                           |
| <b>Barriers experienced by surgeons</b>   |                               |                                                    |
| <b>The Surgeon</b>                        | <i>Understanding</i>          | 13 (72.2)                                          |
|                                           | <i>Culture</i>                | 12 (66.7)                                          |
|                                           | <i>Ownership</i>              | 14 (77.8)                                          |
|                                           | <i>Time constraints</i>       | 11 (61.1)                                          |
| <b>The Institution</b>                    | <i>Provision</i>              | 14 (77.8)                                          |
|                                           | <i>Staffing</i>               | 8 (44.4)                                           |
|                                           | <i>Conflict</i>               | 12 (66.7)                                          |
|                                           | <i>Hospital setting</i>       | 4 (22.2)                                           |
| <b>The Wider Context</b>                  | <i>Research</i>               | 12 (66.7)                                          |
|                                           | <i>External factors</i>       | 9 (50.0)                                           |
| <b>Decision making – emerging theme</b>   |                               |                                                    |
| <b>To join or not to join</b>             | <i>Risk taking</i>            | 11 (61.1)                                          |
|                                           | <i>Site of anastomosis</i>    | 6 (33.3)                                           |
| <b>Nutritional support</b>                | <i>Timing</i>                 | 10 (55.5)                                          |
|                                           | <i>Delivery pathways</i>      | 10 (55.5)                                          |

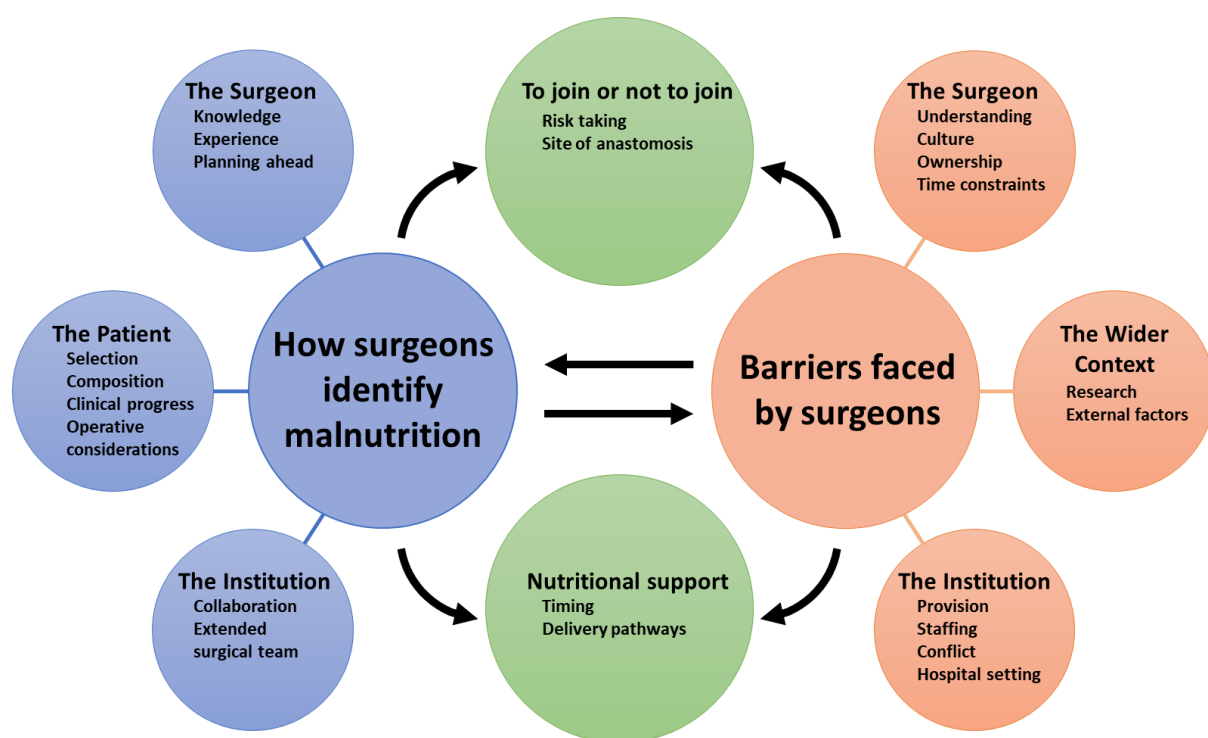


**Figure 5.1:** Themes and subthemes identified: how surgeons identify malnutrition (blue); barriers faced by surgeons (red); emerging themes/ subthemes (green).

## Barriers experienced by surgeons

### The Surgeon

Four subordinate themes were identified which related to The Surgeon. These were 'Understanding', 'Culture', 'Ownership' and 'Time constraints'.

### Understanding

Surgeons admitted a lack of understanding in various areas. These pertained to the importance of nutritional support in EGS, difficulty weighing the risks and benefits of nutritional support, limited awareness that being malnourished is important, and ignorance across all these levels. There was discussion on how to overcome these problems and 'bridge the gaps'. Opportunities to improve understanding centred on teaching packages, empowerment, representation in nutrition multidisciplinary teams (MDTs), and dissemination of learning at surgical conferences.

*'I don't think there's any barriers in me making the decision other than my own ignorance.'* **P3 (DGH)**

### Culture

Surgical nutrition was viewed as a '*non-surgical*' component of surgical care, rife with dogma and old traditions which are perpetuated across generations. For some, an operation was considered paramount to cure patients' problems. Albumin is still considered a common language between surgeons that was thought to be understood by many due to historic misconceptions that it is diagnostic of malnutrition.

*'Surgeons want to 'surge'.'* **P11 (DGH)**

*'It's like an old language, because everyone did believe that albumin was the one and only marker of nutrition.'* **P13 (DGH)**

### Ownership

Many surgeons were ingrained in the belief that they are solely accountable for the patient. However, other surgeons were accepting of guidance from other healthcare professionals and a recognition that identifying and managing nutrition may not fall within a surgeon's expertise. Overall ownership of a patient's care was discussed in almost all interviews, especially when there were disagreements between team members.



*'It's my name above the bed' P9 (TH)*

*'...expecting us to assess and do all this stuff as well as other people is just nuts. It's just old-fashioned thinking.' P18 (DGH)*

### **Time constraints**

Surgeons repeatedly raised the issue that they are busy clinicians. Two main issues arose: a lack of time and a need to prioritise. The former pertained to busy ward rounds, needing to learn how to formally diagnose malnutrition and often because the patient imminently needs an operation.

*'Can you improve the nutrition within 12 hours? [You're] unlikely to make them much fitter.' P15 (DGH)*

Surgeons discussed many conflicting priorities resulting in malnutrition being considered less important. Issues around calculating risk, deciding whether an operation will be of benefit to a patient, speaking with family members, and preparing the patient for theatre meant malnutrition was further down the list of priorities.

*'We've got so many things to focus on...nutrition's probably further down the pecking order at the minute because we know so little about it.' P6 (TH)*

## The Institution

Again, four subordinate themes were identified and related to barriers as a result of The Institution within which surgeons work: 'Provision', 'Staffing', 'Conflict', and 'Hospital setting'.

### Provision

Whilst access to line services and nutritional support was considered adequate by some surgeons, many considered it poor, especially over the weekend when services were not available.

*'Absence of seven-day working is another problem.'* **P12 (TH)**

### Staffing

Staff vacancies were considered a major issue, particularly regarding access to dietitians with appropriate experience. One surgeon explained that even basic care and nutritional support by nursing and auxiliary staff had been affected.

*'...there may be two nurses to 33 patients. They're lucky if they can get some food.'* **P3 (DGH)**

### Conflict

Where collaborative working does not succeed, or there are issues surrounding ownership of patients and their problems, conflict can arise regarding whether to give nutritional support to patients or not. While many surgeons discussed the value of good communication, negotiating plans and 'exit strategies' for patients, a number of surgeons emphasised team members including dietitians and gastroenterologists are often viewed as 'gatekeepers' to nutritional support. This was not an issue for surgeons in IFUs.

*'...getting a unified position, can sometimes be challenging.'* **P6 (TH)**

*'I don't think I've had a request for TPN [total parenteral nutrition] challenged.'* **P14 (IFU)**

### Hospital setting

There were differences in the narrative between non-IF units and IF units. All IFU surgeons discussed this. Surgeons at IFUs described easy access and the presence of supporting teams able to manage nutrition. Additionally, their elective practice informed their EGS practice. Altogether, this appeared

to change clinical decision making, such as having little concern for patients with high-output stomas or patients who would likely need a protracted period of nutritional support.

*'The fact that I work in an IF unit...we'll deal with it.'* **P16 (IFU)**

*'...if you're jobbing away as a jobbing general surgeon, you have to work with what you've got.'* **P18 (DGH)**

## The Wider Context

Two subthemes related to the wider context within in which consultant surgeons work and their ability to identify malnutrition in EGS. These are 'Research' and 'External factors'.

### Research

There was concern for a lack of evidence regarding nutritional support in the EGS setting, including long term outcomes for patients and resultant service implications. This appeared to lead to a reliance on experience and opinion. A number of surgeons commented on the quality of the current data, much of which is not based on randomised-controlled trials, but stated surgeons wouldn't trust it in any case.

*'...if a surgeon doesn't agree with it, they'll just pick holes in it and not believe in it....' P1 (TH)*

Further, it was recognised that although standards do exist, surgeons need to have read them, understood them, and then use them in their practice. It was expressed that dissemination of such guidelines needs to be surgeon-friendly.

*'...it needs to be chalked in a way that surgeons understand.' P9 (TH)*

### External factors

The finite financial resource available was a recurring issue and a root cause of many of the other barriers encountered. Surgeons described the funding of services being stretched that basic nutrition is compromised. A minority of surgeons commented that the nutritional requirements of patients may vary depending on where they live, and that these differences can lead to a 'postcode lottery' effect.

*'...the hospital food is maybe not what they require...it's done very cheaply.' P1 (TH)*

## Discussion

This study used qualitative methods to explore current practice and barriers of consultant surgeons in the identification and management of malnutrition in the emergency setting in the United Kingdom. We confirm variation in how surgeons identify malnutrition and report several contextual barriers that hinder this process, corroborating findings in previous studies(316). We draw attention to three areas that require intervention to improve the nutritional management of EGS patients.

### Surgeon understanding and culture

Surgeons recognised their understanding about how to identify malnutrition was poor. Two approaches still in common use may result in misdiagnosis or missing malnutrition entirely. Firstly, many still place much emphasis on hypoalbuminaemia in diagnosis of malnutrition, drawn by its 'objectivity'. It is still used as a 'language' to convey the nutritional status of a patient – that a patient with hypoalbuminaemia is malnourished. Like malnutrition, hypoalbuminaemia is also prognostic of poor outcomes including mortality(94,267,321); but it is important to dissociate them since many patients with malnutrition have a normal albumin. Conversely, whilst there may be some correlation between hypoalbuminaemia and malnutrition – hypoalbuminaemia is indicative of inflammation which carries a nutritional burden – patients with hypoalbuminaemia are not always malnourished and in need of nutritional support. The pathophysiology of hypoalbuminaemia has been clearly described(100,322,323). Without severe prior malnutrition or in the presence of inflammatory disease, hypoalbuminaemia in the emergency setting does not have a nutritional component(322,324). Consequently, nutritional guidelines all advise that albumin should not be a marker of malnutrition acutely(43,98–101). However, as one surgeon (P11) recognised, surgeons have *'to read them to understand them...and people don't find time to do that, or because it's deemed not necessary.'*

Secondly, surgeons described being able to diagnose malnutrition by *'eyeballing'* patients. One IF unit surgeon stated, *'we don't worry about the fat ones so much.'* Use of this 'end of the bed assessment method' is also recognised by surgeons when identifying high-risk surgical patients(325). Whilst this approach may work for the overtly cachectic patient, it is of little use in others. Obese patients may have micronutrient deficiencies and severe metabolic impairment that will deleteriously impact their operative outcome. Surgeons must recognise it is the patient's hidden internal body processes that are of concern and not their outward appearance. This can only be uncovered by obtaining a nutrition history. Without this, malnutrition will be under-recognised and inappropriately treated(326–328).

The same surgeon recognised *'a philosophical thing around culture and increasingly high BMI [body mass index] being the normal'*. Others recognised the role of dogma and traditions affecting their practice. Literature alludes to the existence of a surgical personality(329–331), norms(210) and culture(332,333). However, nutrition in EGS was often described as *'non-surgical'*. Conscientious surgeons questioned not knowing when best to operate – before or after nutritional support if the diagnosis and time permitted. In an environment where the *'behaviours and practices all mirror one another'*, a change in surgical culture is needed. Modelling the behaviour of senior colleagues based on incorrectly diagnosing who is and who is not malnourished may lead to adverse effects for patients. Significant changes in surgical training may help, as will disseminating the evidence and guidelines *'chalked in a way that surgeons understand'*. A change in surgical safety culture driven by implementing human factors strategies indicates cultural shift is possible in the surgical environment(334,335).

## **Collaborative dialogue**

Surgeons expressed feelings of ownership and duty towards patients. This sentiment has been described previously(210), and often relates to who makes the final decisions regarding a patient's care.

In the context of nutrition in EGS, some surgeons recognised they were not silos. Without the *'luxury'* of time and a limited understanding, some surgeons eagerly collaborated with other healthcare professionals to build solid working relationships. Without these relationships, surgeons stated other surgical colleagues found it *'much more difficult than I do to access these services for these patients'*. Value was seen in the *'expertise'* offered by dietitians and an MDT approach.

However, conflict was described. Circumstances were related to a variety of issues: diagnosing malnutrition; indication and duration for nutritional support; likely clinical progress; what the expected *'exit strategy'* was; and, whether nutritional support would be of benefit at all. Rather than shared-decision making, or deferring to the expertise of their colleagues, surgeons often cited they were *'carrying the can'*. In such scenarios, surgeons described asking dietitians to stop reviewing patients, or even transferred patients to another centre, because *'if it's all just opinion-based then my opinion wins'*. A range of healthcare professionals were viewed as *'gatekeepers'* to starting nutritional support, to the frustration of surgeons. This was not seen at IF units, with one surgeon wondering if they were *'too liberal with nutritional support'*.

Shared-ownership and a flat hierarchy have been suggested to avoid such problems(336,337). However, if surgeons want ultimate control of their patient's nutritional care, significant changes in surgical training, education, assessment and empowerment to challenge colleague's false assumptions and beliefs regarding nutrition in EGS is needed. Other approaches may include surgical representation on nutrition MDTs to aid 'negotiated settlements' with other healthcare professionals.

### **Adequate and equitable service provision**

Finally, surgeons consistently recognised that finite resources within a healthcare system such as in the United Kingdom were a major barrier in EGS nutritional management. This was mainly inhibited by a '*permanent staffing crisis*', a lack of staff experience and limited access to line and nutrition services. These issues have been described previously(338). The cost of providing an EGS service is expected to increase in the United Kingdom(339) and these issues may worsen if funding is not increased accordingly.

Some surgeons battled to know what is best for patients, and this was influenced by the hospital setting they worked in. Clinical decisions, such as to perform an anastomosis or not, were occasionally grounded in whether nutritional support services were available locally. Non-clinical influences such as geography, socioeconomics and resource availability also affects clinical decision making(340,341). As well as having a life changing impact for patients, surgeons expressed regret following intraoperative decisions such as performing a risky anastomosis which resulted in a poor outcome. One surgeon commented he also regretted patients that survived with a stoma, but did not thrive or appear to have a good quality of life afterwards. In contrast, surgeons working in IF units felt they were supported adequately, and the availability of services did not affect their decision making. Their '*privileged position*' meant they could simply '*deal with*' the consequences. Wider issues such as the quality of hospital food and the differential nutritional baseline of patients across the country also exist.

Adequate investment is required to strengthen the provision for malnourished EGS patients so that decisions regarding nutritional support are founded on need rather than availability. This may ease the emotional decisional-burden surgeons experience.

### **Strengths of the study**

A strength of this study is in its methodology. There were planned post-interview debriefs; immersion in the data through transcription of interviews; dual coding and development of themes; and reporting

in line with current guidelines(228). Four of the 18 (22%) surgeons were females. We recognise this may be appear as a gender imbalance, however this is slightly higher than a 2023 UK national consensus which reported just 17% of consultant general surgeons were female(342). Additionally, a range of surgeon experience, subspecialty interest and hospital setting suggest findings may be generalised to other healthcare settings. The qualitative approach provides granularity and an understanding of 'why' that may not be accessible through quantitative studies.

### **Limitations of the study**

There are potential limitations with this study. Self-selection bias was minimised through broad recruitment of 18 surgeons across 16 centres. Surgeons may practise differently to how they described in interviews, but the conduct of the interviews should mitigate any pressure surgeons felt to offer 'correct' answers. The use of case vignettes for surgeons to reflect on, as used by some studies(210), was considered to be unhelpful in this instance. Nutrition is a vastly complex topic; *'the devil is in the detail'*, as one surgeon proffered. Finally, a sample size of 18 was deemed sufficient based on data saturation.



## Conclusion

Several barriers affect the approach surgeons use to determine malnutrition in EGS patients, impacting clinical and operative decisions. This justifies changes in surgeon education, culture, collaborative working, and improved resource and funding for EGS.

## 5.2 The influence of surgeon seniority and intestinal failure experience on identifying malnourished patients in emergency general surgery: a national survey (Paper 4)

### Chapter introduction

The manuscript presented here has been submitted to the RCS Annals and is currently subject to peer review.

**Ashmore DL**, Wilson TR, Halliday V, Lee MJ. The influence of surgeon seniority and intestinal failure experience on identifying malnourished patients in emergency general surgery: a national survey. Submitted to RCS Annals.

### Author Contributions

**Daniel Ashmore:** Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Visualization; Roles/Writing - original draft; Writing - review & editing.

**Timothy Wilson:** Supervision; Visualization; Writing - review & editing

**Vanessa Halliday:** Methodology; Supervision; Visualization; Writing - review & editing

**Matthew Lee:** Methodology; Supervision; Visualization; Writing - review & editing

### Supporting appendices

#### Appendix 4

- Additional files to support Paper 4
  - **Additional File 1:** Research governance
  - **Additional File 2:** Participant invitation email
  - **Additional File 3:** Participant Information Sheet
  - **Additional File 4:** Methodology
  - **Additional File 5:** Initial instrument
  - **Additional File 6:** Final instrument
  - **Additional File 7:** Study user interface
- Supplementary tables for Paper 4
  - **Table S28:** Association of participant response and experience of intestinal failure
  - **Table S29:** Association of participant response and surgeon seniority

- **Table S30:** Reasons why screening for malnutrition is not performed all the time according to surgeon seniority and experience of intestinal failure
- **Table S31:** Responsible person for identifying malnutrition in emergency surgical patients according to surgeon seniority and experience of intestinal failure
- **Table S32:** Responsible person for managing malnutrition in emergency surgical patients according to surgeon seniority and experience of intestinal failure
- **Table S33:** A summary of the free text comments regarding screening and assessment for malnutrition pre- and post-operatively

## Abstract

### Background and aims

Variation exists in how consultant surgeons identify malnutrition in emergency general surgical (EGS) patients. These relate to differences in surgeon knowledge, understanding, ownership and hospital setting. Little is known regarding how these relate to non-consultants' surgeons, or those with experience of intestinal failure (IF). This study aimed to characterise the awareness, practice and training of general surgeons in identifying malnutrition in the emergency setting in the United Kingdom. Differences according to surgeon seniority and experience of intestinal failure were assessed.

### Methods

The survey focussed on three domains: Perceptions around malnutrition in EGS; current practices in identifying malnutrition; and nutrition training and the future. Following piloting and validity assessment, all general surgeons were invited to complete an online survey. Responses were gathered using Qualtrics. Descriptive analysis and associations with surgeon seniority and intestinal failure were performed in performed in SPSSv26. Ethical approval was obtained (UREC 050436). The results from the survey are reported with reference to the CHERRIES guidelines(199).

### Results

The completion rate was 52.1% (148/284), of whom 49.7% were non-consultant surgeons, and 46.6% had experience of intestinal failure (IF). Surgeons from all UK regions completed the survey. There was strong agreement across participants that malnutrition can affect surgical outcomes and identifying it was an important skill for surgeons. However, only 37.2% (55/148) were confident in doing so; surgeons with IF experience were more confident ( $n = 148$ , IF experience median response = 3, no IF experience median response = 3,  $p = 0.008$ ). Training was reportedly poor and local teaching or a short course aimed at surgeons in training was considered most helpful in the future.

### Conclusion

Identifying malnutrition in EGS is recognised as an important skill most surgeons feel they are lacking. Support for formal training in this area was high.

## Introduction

Many emergency general surgery (EGS) patients are admitted with poor oral intake and are at risk of being malnourished during their admission(50,302). It is known that surgical and clinical outcomes are more likely to be worse in malnourished patients compared to those without malnutrition(7,8,50). Recognition of this vulnerable group of patients is paramount to initiate timely nutritional support and potentially improve outcomes.

Studies indicate there is variation in practice(306,316). A lack of training and education for surgeons is considered to be a major barrier to identifying malnourished EGS patients(316,343). This has been explored at consultant level, but no comparisons have been made with non-consultant surgeons, including surgical trainees and associate specialists. Similar findings of a lack of training and education and low confidence in recognising malnourished patients have been established by gastroenterology medical trainees, but not surgical(344).

Further, patients with intestinal failure (IF) are often complex and require long term nutritional support. Their care is often managed by specialised centres, or intestinal failure units. Surgeons working at these units are likely to develop skills they carry forward in their practice at other centres. Perceptions around ease of access and the presence of appropriate teams to manage nutritional support appeared to change surgical clinical decision making. However, the influence of a surgeon's own IF experience in the context of identifying malnourished patients has not been explored.

## Aims

This study aimed to explore the perceptions and practice of general surgeons in identifying and managing malnourished EGS patients. The training surgeons had received, and how this could be improved was also investigated. Secondary aims explored if differences exist according to surgeon seniority or experience of intestinal failure.

## Methods

A cross-sectional survey was designed with reference to current nutrition guidelines and the existing literature(43,98,109,112). The results from the survey are reported with reference to the CHERRIES guidelines(199).

### Study design

The study was designed in two sections which were delivered simultaneously to the same population to limit burden to participants. This included the survey described within, as well as a discrete choice experiment. The latter used scenario-based questions to derive the relevance of certain factors in decision making and will be reported in due course as the underlying aims, methodology and findings are markedly different. The relevant questions pertaining to the survey reported here are provided (Appendix 4).

This survey captured limited demographic data about respondents including grade of surgeon, self-reported experience of managing patients with intestinal failure and current region of work. There were three main domains:

- Perceptions around malnutrition in EGS
- Current practices in identifying malnutrition
- Nutrition training and the future

### Ethical approval and Informed Consent

University of Sheffield ethical approval was obtained (UREC 050436). Potential participants were invited by e-mail to read a Participant Information Sheet. This explained the purpose of the study, how data would be stored, the study investigators and the duration of the survey. Survey consent was implied by participants clicking on a link in the invitation email, and subsequently on another link agreeing to continue on the welcome page.

### Development and pre-testing

The survey was piloted among five consultant and non-consultant general surgeons, assessing for face and content validity using a feedback form based on the validated QQ-10 tool(303). Additional feedback regarding survey design, question wording and completion time were discussed among the expert panel.

Responses from the pilot study confirmed the survey was succinct, easy to complete and was relevant. Free text responses advised the need for fewer questions per page and this was incorporated into the final survey design. The mean time for completion was five minutes for the survey section of the study.

## **Recruitment and survey administration**

Surgeons working at registrar-level or above were eligible to complete the survey. This included surgeons in training and fellows post-certificate of completion of training, as well as SAS (staff grade, associate specialist and specialty doctors) and trust grade surgeons.

The final study was publicised to general surgeons by several routes. This included: surgeons who had previously registered an interest in studies undertaken by the research team; to members of the Association of Surgeons of Great Britain and Ireland (ASGBI), for which the study had received research support; and, via social media platforms to surgical trainee- and EGS-specific groups. Responses were gathered using Qualtrics survey software.

The study opened in December 2023 for 10 weeks with two additional reminders to complete it. There were no incentives. Responses were anonymous, although participants were able to leave their email if they wished to be contacted in the future, be informed of findings or avoid reminder emails. Questions were from a drop-down list, a 5-point Likert question-matrix with a 'do not know' option, or a selection of options from a menu. Instructions to 'select one' or 'select all that apply' were given as appropriate. Questions were adaptively formatted with free text boxes also offered where appropriate. There were up to 8 questions per page displayed on 7 pages including the opening and closure pages; a progress bar was visible. Mandatory questions were indicated and participants were able to review answers until submission.

## **Analysis**

Descriptive analyses were performed in IBM SPSSv26. Associations of response medians with surgeon seniority and experience of intestinal failure were performed using appropriate tests of significance, namely Mann Whitney U. Representative statements from free text data are presented in the findings.



## Results

A total of 284 responses were recorded, of which 149 participants completed the survey. One response was excluded as the participant was a core surgical trainee and not eligible to participate. This resulted in an overall completion rate of 52.1% (148/284). There was an approximately even number of consultants and non-consultants (50.7% vs 49.3%), and surgeons with experience of intestinal failure (46.6%, 69/148) and those without (53.4%, 79/148). Half of the non-consultant surgeons were ST3-6 (50.1%, 37/73). Ten consultants (13.3%, 10/75) worked in an intestinal failure unit. At least one participant from all training regions ('deaneries') in the United Kingdom completed the survey, with the majority from Yorkshire and the Humber (43.2%, 64/148). A summary of the included participants is shown (**Table 5.3**). Mean completion time was 14 minutes (3-101 minutes).

**Table 5.3:** Summary characteristics of the included participants

| Scenario                                      | Responses, % (n) |
|-----------------------------------------------|------------------|
| <b>Grade</b>                                  |                  |
| Consultant                                    | 50.7 (75)        |
| Non-consultant                                | 49.3 (73)        |
| ST7-8/ post-CCT fellow                        | 14.9 (22)        |
| ST3-6                                         | 25.0 (37)        |
| SAS doctor, associate specialist, trust grade | 9.5 (14)         |
| <b>Consultants with IF experience</b>         |                  |
| Yes                                           | 57.3 (43)        |
| No                                            | 42.7 (32)        |
| <b>Participants with IF experience</b>        |                  |
| Yes                                           | 46.6 (69)        |
| No                                            | 53.4 (79)        |
| <b>Consultants working in an IFU</b>          |                  |
| Yes                                           | 13.3 (10)        |
| No                                            | 86.7 (65)        |
| <b>Region of work</b>                         |                  |
| Yorkshire and the Humber                      | 43.2 (64)        |
| North West (North West)                       | 9.5 (14)         |
| West Midlands                                 | 7.4 (11)         |
| Kent, Surrey & Sussex                         | 4.1 (6)          |
| South West (Severn)                           | 3.4 (5)          |
| Wessex                                        | 3.4 (5)          |
| Thames Valley                                 | 2.7 (4)          |
| North West (Mersey)                           | 2.7 (4)          |
| Wales                                         | 2.7 (4)          |
| South West (Peninsula)                        | 2.7 (4)          |
| North East                                    | 2.0 (3)          |
| North West London                             | 2.0 (3)          |
| Northern Ireland                              | 2.0 (3)          |
| East of England                               | 2.0 (3)          |
| Ireland                                       | 2.0 (3)          |
| Scotland (South East - Edinburgh)             | 1.4 (2)          |
| East Midlands (South)                         | 1.4 (2)          |
| East Midlands (North)                         | 1.4 (2)          |
| Scotland (West - Glasgow)                     | 0.7 (1)          |
| South London (South West)                     | 0.7 (1)          |
| North Central & East London                   | 0.7 (1)          |
| South London (South East)                     | 0.7 (1)          |
| Scotland (North - Aberdeen)                   | 0.7 (1)          |
| Scotland (East - Dundee)                      | 0.7 (1)          |

Responses as % (n). Abbreviations: certificate of completion of training (CCT); intestinal failure (IF); intestinal failure unit (IFU); specialty and associate specialist (SAS); specialty trainee (ST).

## Perceptions around malnutrition in EGS

Almost all consultant and non-consultant surgeons agreed or strongly agreed that malnutrition can significantly affect surgical outcomes (98.0%, 145/148) and identifying malnourished patients was an

important skill for surgeons (98.0%, 145/148) (**Table 5.4, Figure 5.2**). This was regardless of experience of intestinal failure.

However, surgeons with IF experience screened more frequently for malnutrition than their colleagues without IF experience (72.5% vs 60.8%, **Table 5.4**), and these were significantly different (n = 148, IF experience median response = 4, no IF experience median response = 4, p = 0.050) (**Table S28**). The screening rates between consultant surgeons and non-consultant surgeons were also significantly different (n = 148, consultant median response = 4, non-consultant median response = 4, p = 0.035, **Table S29**). The commonest reasons reported for not screening all the time were it would not change immediate management, a lack of appropriate training and a lack of time (**Table S30**). These findings were reflected across surgeon grade and IF experience.

In total, only 37.2% (55/148) of all surgeons were confident they could identify malnutrition in EGS patients (**Table 5.4, Figure 5.2**). Confidence among surgeons was low for across all groups. Whilst surgeons with IF experience were significantly more confident compared to surgeons with no IF experience (n = 148, IF experience median response = 3, no IF experience median response = 3, p = 0.008, **Table S28**), similar trends were not seen when comparing consultant to non-consultant surgeons (n = 148, consultant median response = 3, non-consultant median response = 3, p = 0.361, **Table S29**).

Overall, surgeons indicated responsibility for identifying malnourished patients (64.9%, 96/148) rather than managing their malnutrition (57.4%, 85/148) (**Table 5.4**). This difference is greater in consultant surgeons than non-consultant surgeons. Surgeons with IF experience reported primary responsibility for managing malnourished patients more frequently than those without IF experience at both consultant and non-consultant grade. However, none of these findings were significant (**Table S28, Table S29**). Where surgeons indicated they were not responsible for identifying malnutrition, dietitians followed by the nutrition support team were considered to be (**Table S31**), and vice versa for managing malnutrition (**Table S32**).

Only half (51.3%, 76/148) of surgeons felt their organisation supported them to identify and manage malnutrition in EGS (**Table 5.4**). Although consultant surgeons were significantly more likely than non-consultants to say there was adequate support (n = 148, consultant median response = 4, non-consultant median response = 3, p = 0.035, **Table S29**), over 40% were indifferent or disagreed. In

general, surgeons with IF experience were more favourable that organisational support was available than surgeons without IF experience (**Table 5.4**).

**Table 5.4:** Awareness, practice, responsibility and organisational support according to surgeon seniority and experience of intestinal failure

| Question                                                                                                                | Role             | n   | Strongly disagree | Disagree  | Neither agree nor disagree | Agree     | Strongly agree | I do not know |
|-------------------------------------------------------------------------------------------------------------------------|------------------|-----|-------------------|-----------|----------------------------|-----------|----------------|---------------|
| <i>Malnutrition can significantly affect surgical outcomes.</i>                                                         | Cons             | 75  | 1.3 (1)           | 0.0 (0)   | 0.0 (0)                    | 10.7 (8)  | 88.0 (66)      | 0.0 (0)       |
|                                                                                                                         | Non-cons         | 73  | 3.2 (2)           | 0.0 (0)   | 0.0 (0)                    | 11.0 (8)  | 86.3 (63)      | 0.0 (0)       |
|                                                                                                                         | IF experience    | 69  | 2.9 (2)           | 0.0 (0)   | 0.0 (0)                    | 5.8 (4)   | 91.3 (63)      | 0.0 (0)       |
|                                                                                                                         | No IF experience | 79  | 1.3 (1)           | 0.0 (0)   | 0.0 (0)                    | 15.2 (12) | 83.5 (66)      | 0.0 (0)       |
|                                                                                                                         | Total            | 148 | 2.0 (3)           | 0.0 (0)   | 0.0 (0)                    | 10.8 (16) | 87.2 (129)     | 0.0 (0)       |
| <i>Identifying malnourished patients is an important skill for surgeons.</i>                                            | Cons             | 75  | 0.0 (0)           | 0.0 (0)   | 0.0 (0)                    | 29.3 (22) | 70.7 (53)      | 0.0 (0)       |
|                                                                                                                         | Non-cons         | 73  | 0.0 (0)           | 0.0 (0)   | 4.1 (3)                    | 20.5 (15) | 75.3 (55)      | 0.0 (0)       |
|                                                                                                                         | IF experience    | 69  | 0.0 (0)           | 0.0 (0)   | 0.0 (0)                    | 23.2 (16) | 76.8 (53)      | 0.0 (0)       |
|                                                                                                                         | No IF experience | 79  | 0.0 (0)           | 0.0 (0)   | 3.8 (3)                    | 26.6 (21) | 69.6 (55)      | 0.0 (0)       |
|                                                                                                                         | Total            | 148 | 0.0 (0)           | 0.0 (0)   | 2.0 (3)                    | 25.0 (37) | 73.0 (108)     | 0.0 (0)       |
| <i>I screen and/ or assess for malnutrition in all emergency general surgical patients.</i>                             | Cons             | 75  | 0.0 (0)           | 2.7 (2)   | 24.0 (18)                  | 49.3 (37) | 24.0 (18)      | 0.0 (0)       |
|                                                                                                                         | Non-cons         | 73  | 1.4 (1)           | 19.2 (14) | 20.5 (15)                  | 39.7 (29) | 19.2 (14)      | 0.0 (0)       |
|                                                                                                                         | IF experience    | 69  | 1.4 (1)           | 8.7 (6)   | 17.4 (12)                  | 43.5 (30) | 29.0 (20)      | 0.0 (0)       |
|                                                                                                                         | No IF experience | 79  | 0.0 (0)           | 12.7 (10) | 26.6 (21)                  | 45.6 (36) | 15.2 (12)      | 0.0 (0)       |
|                                                                                                                         | Total            | 148 | 0.7 (1)           | 10.8 (16) | 22.3 (33)                  | 44.6 (66) | 21.6 (32)      | 0.0 (0)       |
| <i>I am confident I can identify all malnourished emergency surgical patients.</i>                                      | Cons             | 75  | 1.3 (1)           | 26.7 (20) | 32.0 (24)                  | 30.7 (23) | 9.3 (7)        | 0.0 (0)       |
|                                                                                                                         | Non-cons         | 73  | 1.4 (1)           | 30.1 (22) | 34.2 (25)                  | 31.5 (23) | 2.7 (2)        | 0.0 (0)       |
|                                                                                                                         | IF experience    | 69  | 1.4 (1)           | 23.2 (16) | 26.1 (18)                  | 37.7 (26) | 11.6 (8)       | 0.0 (0)       |
|                                                                                                                         | No IF experience | 79  | 1.3 (1)           | 32.9 (26) | 39.2 (31)                  | 25.3 (20) | 1.3 (1)        | 0.0 (0)       |
|                                                                                                                         | Total            | 148 | 1.4 (2)           | 28.4 (42) | 33.1 (49)                  | 31.1 (46) | 6.1 (9)        | 0.0 (0)       |
| <i>Surgeons are primarily responsible for identifying malnutrition in emergency surgical patients.</i>                  | Cons             | 75  | 0.0 (0)           | 9.3 (7)   | 26.7 (20)                  | 50.7 (38) | 13.3 (10)      | 0.0 (0)       |
|                                                                                                                         | Non-cons         | 73  | 0.0 (0)           | 9.6 (7)   | 24.7 (18)                  | 46.6 (34) | 19.2 (14)      | 0.0 (0)       |
|                                                                                                                         | IF experience    | 69  | 0.0 (0)           | 7.2 (5)   | 30.4 (21)                  | 47.8 (33) | 14.5 (10)      | 0.0 (0)       |
|                                                                                                                         | No IF experience | 79  | 0.0 (0)           | 11.4 (9)  | 21.5 (17)                  | 49.4 (39) | 17.7 (14)      | 0.0 (0)       |
|                                                                                                                         | Total            | 148 | 0.0 (0)           | 9.5 (14)  | 25.7 (38)                  | 48.6 (72) | 16.2 (24)      | 0.0 (0)       |
| <i>Surgeons are primarily responsible for managing malnutrition in emergency surgical patients.</i>                     | Cons             | 75  | 1.3 (1)           | 14.7 (11) | 29.3 (22)                  | 36.0 (27) | 18.7 (14)      | 0.0 (0)       |
|                                                                                                                         | Non-cons         | 73  | 1.4 (1)           | 12.3 (9)  | 26.0 (19)                  | 47.9 (35) | 12.3 (9)       | 0.0 (0)       |
|                                                                                                                         | IF experience    | 69  | 2.9 (2)           | 10.1 (7)  | 21.7 (15)                  | 46.4 (32) | 18.8 (13)      | 0.0 (0)       |
|                                                                                                                         | No IF experience | 79  | 0.0 (0)           | 16.5 (13) | 32.9 (26)                  | 38.0 (30) | 12.7 (10)      | 0.0 (0)       |
|                                                                                                                         | Total            | 148 | 1.4 (2)           | 13.5 (20) | 27.7 (41)                  | 41.9 (62) | 15.5 (23)      | 0.0 (0)       |
| <i>My organisation provides the support I need to identify and manage all malnourished emergency surgical patients.</i> | Cons             | 75  | 0.0 (0)           | 12.0 (9)  | 30.7 (23)                  | 36.0 (27) | 20.0 (15)      | 1.3 (1)       |
|                                                                                                                         | Non-cons         | 73  | 1.4 (1)           | 23.3 (17) | 27.4 (20)                  | 39.7 (29) | 6.8 (5)        | 1.4 (1)       |
|                                                                                                                         | IF experience    | 69  | 0.0 (0)           | 14.5 (10) | 29.0 (20)                  | 36.2 (25) | 18.8 (13)      | 1.4 (1)       |
|                                                                                                                         | No IF experience | 79  | 1.3 (1)           | 20.3 (16) | 29.1 (23)                  | 39.2 (31) | 8.9 (7)        | 1.3 (1)       |
|                                                                                                                         | Total            | 148 | 0.7 (1)           | 17.6 (26) | 29.1 (43)                  | 37.8 (56) | 13.5 (20)      | 1.4 (2)       |

Responses as % (n). Abbreviations: cons (consultant); intestinal failure (IF); intestinal failure unit (IFU); non-cons (non-consultant); specialty and associate specialist (SAS); specialty trainee (ST). Note ST7-8 category also includes post-CCT fellows.

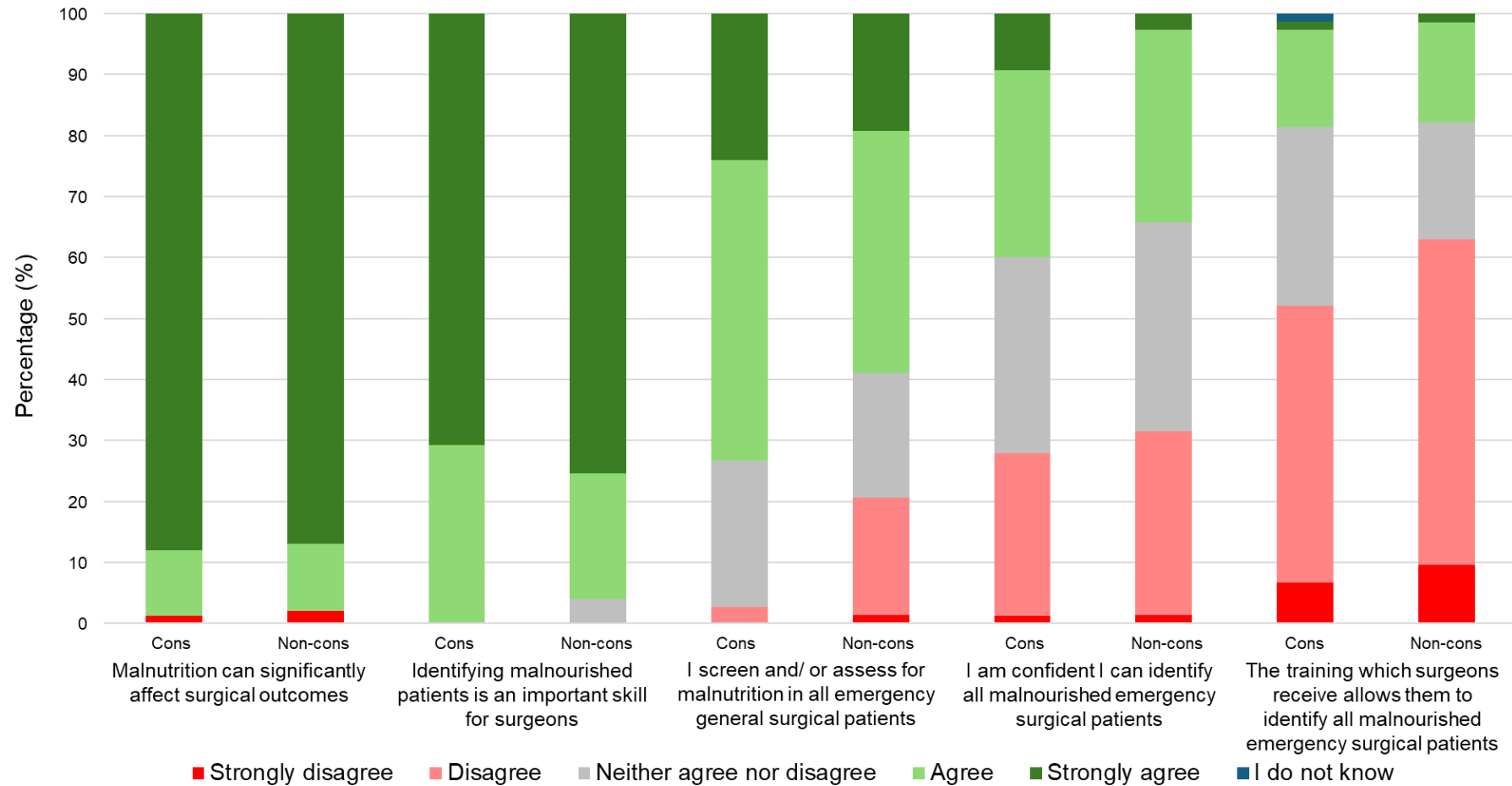


**Figure 5.2:** Perceptions of consultant and non-consultant surgeons

Abbreviations: consultant (cons); non-consultant (non-cons).

## Current practices in identifying malnutrition

Reduced oral intake until now, followed by reduced oral intake from now and an end of the bed 'clinical impression' were the most commonly used methods overall at 95.3%, 89.2% and 84.6% respectively (**Table 5.5, Figure 5.3**).

There was wide variation in the use of MUST, body mass index and percentage weight loss over time, with consultants using each method significantly more than non-consultants (**Table 5.5**). Non-consultants used albumin (65.7%, 48/73) more than consultants (60.0%, 45/75). Except for weight loss and the use of the Malnutrition Universal Screening Tool, or its Wales equivalent, the Weight, Appetite, Ability to eat, Stress Factor, Pressure ulcer/ wound (WAASP), IF experience did not confer any significant difference to which tool or method was used to identify malnutrition (**Table S28**).

**Table 5.5:** Measures used to determine nutritional status according to surgeon seniority and experience of intestinal failure

| Question                                | Role             | n   | Never     | Rarely    | Occasionally | Regularly | All the time | I do not know |
|-----------------------------------------|------------------|-----|-----------|-----------|--------------|-----------|--------------|---------------|
| <i>MUST or WAASP</i>                    | Cons             | 75  |           |           |              |           |              | 0.0 (0)       |
|                                         |                  |     | 13.3 (10) | 12.0 (9)  | 20.0 (15)    | 36.0 (27) | 18.7 (14)    |               |
|                                         | Non-cons         | 73  | 21.9 (16) | 34.2 (25) | 17.8 (13)    | 17.8 (13) | 8.2 (6)      | 0.0 (0)       |
|                                         | IF experience    | 69  | 10.1 (7)  | 15.9 (11) | 15.9 (11)    | 34.8 (24) | 23.2 (16)    | 0.0 (0)       |
|                                         | No IF experience | 79  | 24.1 (19) | 29.1 (23) | 21.5 (17)    | 20.3 (16) | 5.1 (4)      | 0.0 (0)       |
|                                         | Total            | 148 | 17.6 (26) | 23.0 (34) | 18.9 (28)    | 27.0 (40) | 13.5 (20)    | 0.0 (0)       |
| <i>Albumin</i>                          | Cons             | 75  |           |           |              |           |              | 0.0 (0)       |
|                                         |                  |     | 6.7 (5)   | 16.0 (12) | 17.3 (13)    | 32.0 (24) | 28.0 (21)    |               |
|                                         | Non-cons         | 73  | 9.6 (7)   | 11.0 (8)  | 13.7 (10)    | 45.2 (33) | 20.5 (15)    | 0.0 (0)       |
|                                         | IF experience    | 69  | 5.8 (4)   | 18.8 (13) | 14.5 (10)    | 36.2 (25) | 24.6 (17)    | 0.0 (0)       |
|                                         | No IF experience | 79  | 10.1 (8)  | 8.9 (7)   | 16.5 (13)    | 40.5 (32) | 24.1 (19)    | 0.0 (0)       |
|                                         | Total            | 148 | 8.1 (12)  | 13.5 (20) | 15.5 (23)    | 38.5 (57) | 24.3 (36)    | 0.0 (0)       |
| <i>Body mass index</i>                  | Cons             | 75  | 2.7 (2)   | 10.7 (8)  | 17.3 (13)    | 45.3 (34) | 24.0 (18)    | 0.0 (0)       |
|                                         | Non-cons         | 73  | 4.1 (3)   | 13.7 (10) | 24.7 (18)    | 45.2 (33) | 12.3 (9)     | 0.0 (0)       |
|                                         | IF experience    | 69  | 4.3 (3)   | 10.1 (7)  | 23.2 (16)    | 46.4 (32) | 15.9 (11)    | 0.0 (0)       |
|                                         | No IF experience | 79  | 2.5 (2)   | 13.9 (11) | 19.0 (15)    | 44.3 (35) | 20.3 (16)    | 0.0 (0)       |
|                                         | Total            | 148 | 3.4 (5)   | 12.2 (18) | 20.9 (31)    | 45.3 (67) | 18.2 (27)    | 0.0 (0)       |
| <i>Percentage weight loss over time</i> | Cons             | 75  | 5.3 (4)   | 13.3 (10) | 24.0 (18)    | 40.0 (30) | 17.3 (13)    | 0.0 (0)       |
|                                         | Non-cons         | 73  | 9.6 (7)   | 27.4 (20) | 31.5 (23)    | 24.7 (18) | 5.5 (4)      | 1.4 (1)       |
|                                         | IF experience    | 69  | 5.8 (4)   | 10.1 (7)  | 29.0 (20)    | 39.1 (27) | 15.9 (11)    | 0.0 (0)       |
|                                         | No IF experience | 79  | 8.9 (7)   | 29.1 (23) | 27.8 (22)    | 26.6 (21) | 7.6 (6)      | 0.0 (0)       |
|                                         | Total            | 148 | 7.4 (11)  | 20.3 (30) | 27.7 (41)    | 32.4 (48) | 11.5 (17)    | 0.7 (1)       |
| <i>Reduced oral intake *until now*</i>  | Cons             | 75  | 0.0 (0)   | 0.0 (0)   | 5.3 (4)      | 37.3 (28) | 57.3 (43)    | 0.0 (0)       |
|                                         | Non-cons         | 73  | 0.0 (0)   | 0.0 (0)   | 4.1 (3)      | 34.2 (25) | 61.6 (45)    | 0.0 (0)       |
|                                         | IF experience    | 69  | 0.0 (0)   | 0.0 (0)   | 7.2 (5)      | 34.8 (24) | 58.0 (40)    | 0.0 (0)       |
|                                         | No IF experience | 79  | 0.0 (0)   | 0.0 (0)   | 2.5 (2)      | 36.7 (29) | 60.8 (48)    | 0.0 (0)       |
|                                         | Total            | 148 | 0.0 (0)   | 0.0 (0)   | 4.7 (7)      | 35.8 (53) | 59.5 (88)    | 0.0 (0)       |
| <i>Reduced oral intake *from now*</i>   | Cons             | 75  | 1.3 (1)   | 1.3 (1)   | 6.7 (5)      | 41.3 (31) | 49.3 (37)    | 0.0 (0)       |
|                                         | Non-cons         | 73  | 0.0 (0)   | 4.1 (3)   | 8.2 (6)      | 31.5 (23) | 56.2 (41)    | 0.0 (0)       |
|                                         | IF experience    | 69  | 1.4 (1)   | 4.3 (3)   | 8.7 (6)      | 36.2 (25) | 49.3 (34)    | 0.0 (0)       |
|                                         | No IF experience | 79  | 0.0 (0)   | 1.3 (1)   | 6.3 (5)      | 36.7 (29) | 55.7 (44)    | 0.0 (0)       |
|                                         | Total            | 148 | 0.7 (1)   | 2.7 (4)   | 7.4 (11)     | 36.5 (54) | 52.7 (78)    | 0.0 (0)       |
| <i>End of bed clinical impression</i>   | Cons             | 75  | 2.7 (2)   | 0.0 (0)   | 12.0 (9)     | 29.3 (22) | 56.0 (42)    | 0.0 (0)       |
|                                         | Non-cons         | 73  | 1.4 (1)   | 4.1 (3)   | 11.0 (8)     | 39.7 (29) | 43.8 (32)    | 0.0 (0)       |
|                                         | IF experience    | 69  | 0.0 (0)   | 1.4 (1)   | 10.1 (7)     | 34.8 (24) | 53.6 (37)    | 0.0 (0)       |
|                                         | No IF experience | 79  | 3.8 (3)   | 2.5 (2)   | 12.7 (10)    | 34.2 (27) | 46.8 (37)    | 0.0 (0)       |
|                                         | Total            | 148 | 2.0 (3)   | 2.0 (3)   | 11.5 (17)    | 34.5 (51) | 50.0 (74)    | 0.0 (0)       |

Responses as % (n). Abbreviations: cons (consultant); intestinal failure (IF); intestinal failure unit (IFU); Malnutrition Universal Screening Tool (MUST); non-cons (non-consultant); specialty and associate specialist (SAS); specialty trainee (ST); Weight, Appetite, Ability to eat, Stress Factor, Pressure ulcer/ wound (WAASP). Note ST7-8 category also includes post-CCT fellows.



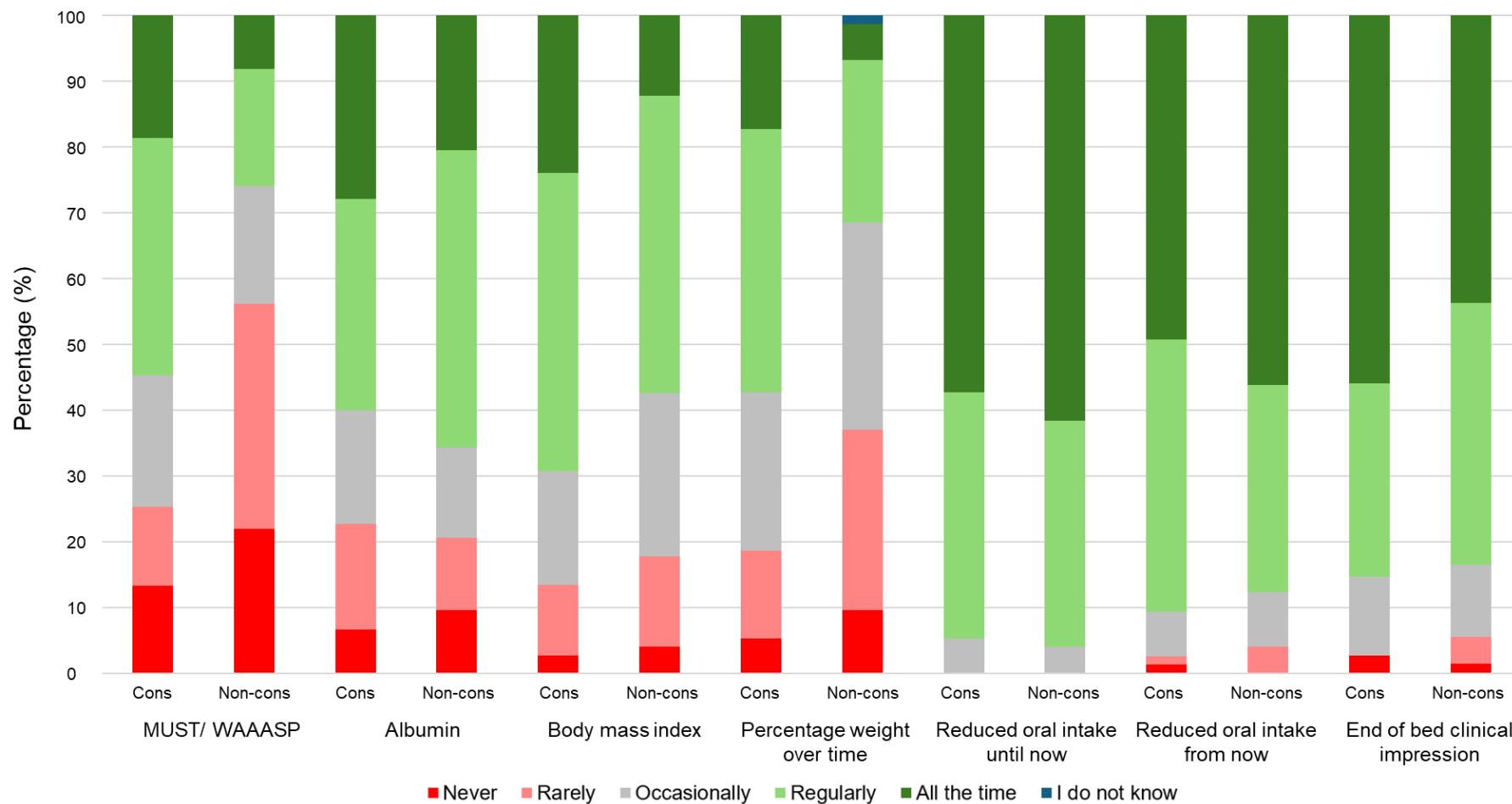


**Figure 5.3:** Methods to identify malnutrition by consultant and non-consultant surgeons

Abbreviations: cons (consultant); Malnutrition Universal Screening Tool (MUST); non-cons (non-consultant); Weight, Appetite, Ability to eat, Stress Factor, Pressure ulcer/ wound (WAAASP).

## Nutrition training and the future

A majority of surgeons, across all grades and IF experience, responded that the training they received does not allow them to identify malnourished surgical patients (**Table 5.6**). Despite this, consultants and those with IF experience reported a far greater likelihood of using evidenced-based medicine when determining if a patient is malnourished compared to non-consultants and surgeons with no IF experience.

Surgeons regularly seek advice from colleagues when deciding if a patient is malnourished (**Table 5.6**). In order of frequency, advice from the nutrition support team, learning from previous surgical cases and advice from other surgical colleagues are the main approaches surgeons used to do so (**Table 5.7**). This is regardless of surgeon seniority or IF experience (**Table 5.7**). Undergraduate training is lacking, with only 1 in 8 surgeons reportedly being trained at medical school; even fewer (6.6%, 25/379 responses) reported to have attended a postgraduate training course.

For all participants regardless of surgeon seniority or IF experience, a specific local teaching session or a short course aimed at surgeons in training were reported to be most helpful in improving nutritional assessment/ management. Only one in five recommend additional teaching at medical school (**Table 5.8**).

**Table 5.6:** Training, use of evidence-based practice and collaboration with colleagues according to surgeon seniority and experience of intestinal failure

| Question                                                                                                         | Role             | n   | Never    | Rarely    | Occasionally | Regularly | All the time | I do not know |
|------------------------------------------------------------------------------------------------------------------|------------------|-----|----------|-----------|--------------|-----------|--------------|---------------|
| <i>The training which surgeons receive allows them to identify all malnourished emergency surgical patients.</i> | Cons             | 75  | 6.7 (5)  | 45.3 (34) | 29.3 (22)    | 16.0 (12) | 1.3 (1)      | 1.3 (1)       |
|                                                                                                                  | Non-cons         | 73  | 9.6 (7)  | 53.4 (39) | 19.2 (14)    | 16.4 (12) | 1.4 (1)      | 0.0 (0)       |
|                                                                                                                  | IF experience    | 69  | 4.3 (3)  | 47.8 (33) | 29.0 (20)    | 15.9 (11) | 2.9 (2)      | 0.0 (0)       |
|                                                                                                                  | No IF experience | 79  | 11.4 (9) | 50.6 (40) | 20.3 (16)    | 16.5 (13) | 1.3 (1)      | 0.0 (0)       |
|                                                                                                                  | Total            | 148 | 8.1 (12) | 49.3 (73) | 24.3 (36)    | 16.2 (24) | 1.4 (2)      | 0.7 (1)       |
| <i>I use evidenced-based practice when deciding a patient is malnourished.</i>                                   | Cons             | 75  | 1.3 (1)  | 16.0 (12) | 29.3 (22)    | 42.7 (32) | 6.7 (5)      | 4.0 (3)       |
|                                                                                                                  | Non-cons         | 73  | 4.1 (3)  | 19.2 (14) | 37.0 (27)    | 30.1 (22) | 2.7 (2)      | 6.8 (5)       |
|                                                                                                                  | IF experience    | 69  | 0.0 (0)  | 17.4 (12) | 26.1 (18)    | 47.8 (33) | 5.8 (4)      | 2.9 (2)       |
|                                                                                                                  | No IF experience | 79  | 5.1 (4)  | 17.7 (14) | 39.2 (31)    | 26.6 (21) | 3.8 (3)      | 7.6 (6)       |
|                                                                                                                  | Total            | 148 | 2.7 (4)  | 17.6 (26) | 33.1 (49)    | 36.5 (54) | 4.7 (7)      | 5.4 (8)       |
| <i>I seek help or advice from colleagues when deciding a patient is malnourished.</i>                            | Cons             | 75  | 1.3 (1)  | 14.7 (11) | 18.7 (14)    | 40.0 (30) | 25.3 (19)    | 0.0 (0)       |
|                                                                                                                  | Non-cons         | 73  | 0.0 (0)  | 6.8 (5)   | 21.9 (16)    | 49.3 (36) | 21.9 (16)    | 0.0 (0)       |
|                                                                                                                  | IF experience    | 69  | 0.0 (0)  | 14.5 (10) | 17.4 (12)    | 42.0 (29) | 26.1 (18)    | 0.0 (0)       |
|                                                                                                                  | No IF experience | 79  | 1.3 (1)  | 7.6 (6)   | 22.8 (18)    | 46.8 (37) | 21.5 (17)    | 0.0 (0)       |
|                                                                                                                  | Total            | 148 | 0.7 (1)  | 10.8 (16) | 20.3 (30)    | 44.6 (66) | 23.6 (35)    | 0.0 (0)       |

Responses as % (n). Abbreviations: cons (consultant); intestinal failure (IF); intestinal failure unit (IFU); non-cons (non-consultant); specialty and associate specialist (SAS); specialty trainee (ST). Note ST7-8 category also includes post-CCT fellows.

**Table 5.7:** Origin of nutrition training according to surgeon seniority and experience of intestinal failure

| Role                    | n   | Medical school | Training course | Advice from or observation of a surgical colleague | Advice from the nutrition support team or another allied health professional | Learned from my previous patient cases | I do not know | Other    |
|-------------------------|-----|----------------|-----------------|----------------------------------------------------|------------------------------------------------------------------------------|----------------------------------------|---------------|----------|
| <i>Cons</i>             | 191 | 13.6 (26)      | 8.4 (16)        | 18.8 (36)                                          | 27.2 (52)                                                                    | 26.2 (50)                              | 1.0 (2)       | 4.7 (9)  |
| <i>Non-cons</i>         | 188 | 13.3 (25)      | 4.8 (9)         | 27.1 (51)                                          | 25.5 (48)                                                                    | 25.5 (48)                              | 2.1 (4)       | 1.6 (3)  |
| <i>IF experience</i>    | 185 | 13.5 (25)      | 7.6 (14)        | 21.6 (40)                                          | 25.9 (48)                                                                    | 25.4 (47)                              | 1.6 (3)       | 4.3 (8)  |
| <i>No IF experience</i> | 194 | 13.4 (26)      | 5.7 (11)        | 24.2 (47)                                          | 26.8 (52)                                                                    | 26.3 (51)                              | 1.5 (3)       | 2.1 (4)  |
| <i>Total</i>            | 379 | 13.5 (51)      | 6.6 (25)        | 23.0 (87)                                          | 26.4 (100)                                                                   | 25.9 (98)                              | 1.6 (6)       | 3.2 (12) |

Responses as % (n). Abbreviations: cons (consultant); intestinal failure (IF); intestinal failure unit (IFU); non-cons (non-consultant); specialty and associate specialist (SAS); specialty trainee (ST). Note ST7-8 category also includes post-CCT fellows.

**Table 5.8:** Methods to improve nutrition training according to surgeon seniority and experience of intestinal failure

| Role                    | n   | Specific teaching at medical school | A specific local or Deanery teaching session | A 1-2 day course aimed at surgeons in training | A postgraduate course | I do not know | Other   |
|-------------------------|-----|-------------------------------------|----------------------------------------------|------------------------------------------------|-----------------------|---------------|---------|
| <i>Cons</i>             | 135 | 20.0 (27)                           | 26.7 (36)                                    | 34.1 (46)                                      | 14.8 (20)             | 1.5 (2)       | 3.0 (4) |
| <i>Non-cons</i>         | 114 | 17.5 (20)                           | 36.0 (41)                                    | 28.9 (33)                                      | 14.9 (17)             | 2.6 (3)       | 0.0 (0) |
| <i>IF experience</i>    | 123 | 17.9 (22)                           | 30.9 (38)                                    | 33.3 (41)                                      | 14.6 (18)             | 1.6 (2)       | 1.6 (2) |
| <i>No IF experience</i> | 126 | 19.8 (25)                           | 31.0 (39)                                    | 30.2 (38)                                      | 15.1 (19)             | 2.4 (3)       | 1.6 (2) |
| <i>Total</i>            | 249 | 18.9 (47)                           | 30.9 (77)                                    | 31.7 (79)                                      | 14.9 (37)             | 2.0 (5)       | 1.6 (4) |

Responses as % (n). Abbreviations: cons (consultant); intestinal failure (IF); intestinal failure unit (IFU); non-cons (non-consultant); specialty and associate specialist (SAS); specialty trainee (ST). Note ST7-8 category also includes post-CCT fellows.

## Free text comments

Surgeons offered many comments regarding aspects of nutrition practice and training, which reiterate the variability in practice and numerous methods sought to learn about surgical nutrition (**Table S33**).

## Discussion

This national survey explored the perceptions and practice of consultant and non-consultant general surgeons in identifying and managing malnourished EGS patients. It also explored whether responses were associated with reported experience of intestinal failure.

There is wide variation in practice among consultant and non-consultant general surgeons. Regardless of surgeon seniority or experience of intestinal failure, malnutrition is considered an important component of being a general surgeon, but it is poorly taught at undergraduate and post-graduate level.

### Perceptions around malnutrition in EGS

Almost all surgeons appreciated that a patient's nutrition impacts surgical outcomes and identifying malnutrition was recognised as an important skill for surgeons. This was irrespective of seniority or experience of IF. Contradicting this however is that only two-thirds of surgeons reported regularly screening for malnutrition, or felt it was their role to do so from the outset. A similar study reports participants screened only 25% of patients every time(306). Even fewer surgeons felt it was their role to manage malnourished EGS patients. There was no significance according to seniority or IF experience, although there was a trend that junior surgeons and those with IF experience felt more responsible on both accounts. Together, surgeons considered these processes should be led by dietitians and the nutrition support team. This lack of ownership has been previously documented(316,345).

There are two reasons that may explain the above findings. First, only 37.2% felt confident they could identify malnourished EGS patients. These findings were reflected across surgeon grade and IF experience, although surgeons with IF experience were significantly more confident than those without. It may be that the knowledge and skills gained from working with IF patients translate into the confident and routine practice of identifying the potential for such patients. Second, only 17.6% of surgeons felt adequately trained to screen for malnutrition. Whilst it is a key knowledge requirement of the trainee surgical curriculum, there are no statutory assessments for this skills specifically(346). Clearly, adequate training will boost confidence, and may empower surgeons to feel involved in decision making around nutritional support for patients.

## **Current practices in identifying malnutrition**

As previously reported, several methods to identify malnourished patients prevail(301,316). NICE suggests the Malnutrition Universal Screening Tool (MUST) is an acceptable tool to screen for malnutrition, and it is widely adopted in the UK. Forty percent of surgeons in this study report using it, or the Wales equivalent WAASP, regularly or all the time. This is not too dissimilar from our previous study whereby over half of NELA Leads reported MUST was the screening tool of choice compared to other tools(316). However, of all screening methods presented, it was reported to be the least used method by which surgeons identify malnutrition. This may be due to its inability to stratify malnutrition risk in the EGS cohort as many patients will be at high risk of malnutrition. It may lead to the perception by surgeons that screening for malnutrition is unlikely to change the immediate management, the commonest reason cited for not doing so in this study.

On the contrary, more than 95% of surgeons used reduced oral intake until now, and almost 90% used reduced oral intake from now. A national study of patients with small bowel obstruction showed more than half of patients who are considered to be at severe risk of malnutrition had no enteral intake for more than five days with a 16% in-hospital mortality rate(50). A patient's oral intake relies on a thorough history, potentially from relatives, and is ideally obtained at the start of their admission. Predicting future oral intake is subject to a number of dynamic elements of a patient's journey including ongoing management and clinical progress. This difficult process can be subjective and influenced by a surgeon's prior experience. However, it is paramount to recognise the additive effect of a 'few days of reduced oral intake until now' as well as a 'few days of reduced oral intake from now'. Patients may have little to no oral intake for longer than we realise. They may become malnourished during their admission and have a significant risk of dying in hospital. The story begins from the onset of symptoms, not from their first presentation to hospital.

Albumin was reported to be commonly used by surgeons to identify malnourished patients. It is used less frequently by more senior surgeons and those with IF experience, which may confer a familiarity with guidelines recommending not using it(43,98–100,262). We have previously explored the use of albumin in the acute setting(316), and reiterate that although it may indicate potential disastrous surgical outcomes, it should not be used specifically to identify malnourished patients.

## **Nutrition training and the future**

At the end of training, surgeons are expected to 'recognise and assess nutritional requirements of the patient and appropriate routes of administration of nutrition'(346). However, surgeons reported a

worrying lack of nutrition training in the UK at undergraduate and postgraduate level. Other studies of undergraduates, foundation doctors(347) and surgeons(343) report similar findings. While foundation doctors report training consisting of two hours in the past year(347), almost all surgeons report never having received any training in nutrition(343). This may explain why more than half of surgeons felt they were unable to identify malnourished surgical patients, which was worse for non-consultant surgeons and those with no experience of IF. It may also explain the collaborative approach surgeons take and advice from colleagues and allied nutrition teams surgeons seek.

The variability of nutrition-related learning outcomes across a range of postgraduate programmes has been documented(348). The curriculum for gastroenterologists has substantially more nutrition-related curriculum outcomes than the curriculum for general surgeons. Surgeons seek advice from gastroenterologists who play a vital role in nutrition support teams. However, similar to the findings of this study, trainee gastroenterologists recognise the importance of nutrition but have low confidence in managing IF as a result of inadequate training opportunities(344). This is despite an expectation of 3-6 months nutrition-focused training, with some trainees undertaking a year-long 'advanced training placement' at a specialist centre; neither of which surgeons undertake. Mandating surgical trainees to undertake such rotations, while aspirational, will be difficult to achieve in an already compressed programme. However, the sheer volume of malnourished surgical EGS patients and deleterious outcomes necessitates urgent change. The management of malnourished EGS patients will not be reserved for specialised intestinal units.

A variety of strategies to change address the lack of nutrition training are available. The involvement of surgeons in nutrition multidisciplinary teams, particularly for EGS patients, would be helpful. The vast majority of surgeons recommended a specific local teaching session or a short course aimed at surgeons in training. The development of a postgraduate course by professional surgical associations may be of benefit, akin to the development of the non-technical skills for surgeons (NOTSS) course(349).

## **Strengths of the study**

This study is wide ranging and captures surgeon perceptions from every region across the UK, benefiting from research support from the Association of Surgeons in Great Britain and Ireland (ASGBI). Approximately equal numbers of consultants to non-consultants, and surgeons with and without experience of IF is testament to this. Exploring the association of these factors with participant responses adds to the depth of this study.



## **Limitations of the study**

The limitations of this study however are its relatively small numbers in comparison to the 4,889 registered general surgeons in the NHS in March 2022 (2,605 consultants and 2,284 non-consultants)(350). A proportion of these will be breast surgeons and surgeons that do not participate on the EGS rota. Further, experience of IF was not defined, and doing so may have been arbitrary in a competency-based curriculum. Finally, a degree of selection bias may exist, exacerbated by the increased completion time as a result of combining this survey with a discrete choice experiment.

## Conclusion

Irrespective of seniority and IF experience, surgeons recognise malnutrition is important and can affect patient outcomes. They lack confidence in identifying malnourished EGS patients, and there is a desire for training to bridge the knowledge gap that exists.

## 5.3 What influences emergency general surgeons' treatment preferences for patients requiring nutritional support? A discrete choice experiment (Paper 5)

### Chapter introduction

The manuscript presented here has been submitted to RCS Annals and is currently subject to peer review.

**Ashmore DL**, Morgan J, Wilson TR, Halliday V, Lee MJ. What influences emergency general surgeons' treatment preferences for patients requiring nutritional support? A discrete choice experiment. Submitted to Colorectal Disease.

### Author Contributions

**Daniel Ashmore:** Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Visualization; Roles/Writing - original draft; Writing - review & editing.

**Jenna Morgan:** Formal analysis; Investigation; Methodology; Supervision; Visualization; Writing - review & editing

**Timothy Wilson:** Supervision; Visualization; Writing - review & editing

**Vanessa Halliday:** Methodology; Supervision; Visualization; Writing - review & editing

**Matthew Lee:** Methodology; Supervision; Visualization; Writing - review & editing

### Supporting appendices

#### Appendix 5

- Additional files to support Paper 5
  - **Additional File 1:** Research governance
  - **Additional File 2:** DCE development
  - **Additional File 3:** Final instrument
- Supplementary tables for Paper 5
  - **Table S34:** Preferences for nutritional support for each scenario according to surgeon seniority

- **Table S35:** Preferences for nutritional support for each scenario for consultants
- **Table S36:** Preferences for nutritional support for each scenario according to experience of intestinal failure

## Abstract

### Background and aims

Identifying malnourished emergency general surgical patients can be difficult. There are many tools available, a range of barriers to overcome and variety of guidelines at a surgeon's disposal. However, the impact of previously identified drivers of clinical decision making have not been investigated. This study aimed to determine surgeon preference to start nutritional support in the emergency setting, and identify any differences between surgeon and intestinal failure (IF) experience.

### Methods

A Discrete Choice Experiment (DCE) was used to determine the impact of six key variables (management/ operation; albumin level; body mass index (BMI); unintentional weight loss; days without oral intake until now; days likely to be without oral intake from now) on surgeons' treatment preferences for nutritional support in the emergency setting. Twenty-five hypothetical scenarios regarding a patient with adhesional small bowel obstruction were disseminated electronically. Binomial logistic regression was used to identify associations between the variables and treatment preference. Ethical approval was obtained (UREC 050436).

### Results

There were 148 participant responses totalling 3,700 scenario responses. Response rate was 52.1% (148/284) with an approximately even split of consultants and non-consultants (50.7% vs 49.3%) and IF experience (46.6% experienced vs 53.4% not experienced). Consultants favoured starting nutritional support (77.7%; 1443/1875) more often than non-consultants (71.8%; 1310/1825). Forming an anastomosis, hypoalbuminaemia, underweight (BMI <18.5Kg/m<sup>2</sup>) and obesity (BMI >30Kg/m<sup>2</sup>), unintentional weight loss (>10%), ≥5 days without oral intake until now and ≥5 days likely to be without oral intake from now demonstrated a significant association with treatment preference ( $p < 0.05$ ). Overall, experience of IF (OR 1.093, 95% CI 0.732–1.631;  $p = 0.663$ ) nor seniority of surgeon (OR 1.406, 95% CI 0.936–2.114;  $p = 0.100$ ) significantly influenced the results.

### Conclusions

There are many variables that impact the decision to start nutritional support in EGS, but surgeon and IF experience do not. Days likely to be without oral intake from now influenced decision making most.

## Introduction

Emergency general surgical (EGS) patients may be malnourished or can become so during their hospital admission(50). Malnutrition is associated with poor surgical outcomes(8,48,51). It can be considered a modifiable risk factor if appropriate and adequate nutritional support is initiated(50).

Previous work has shown there are several approaches used by surgeons to identify malnourished EGS patients, and these patients may benefit from nutritional support(301,316). Guidelines exist regarding initiation and timing of nutritional support, but they lack consistency and focus on the elective setting(43,98,109). The mantra that oral intake is preferred to enteral tube feeding, which is preferred to parenteral nutrition (PN) prevails. Nutritional support is recommended for malnourished patients or those at risk of malnutrition within five days of admission according to the National Institute of Health and Care Excellence (NICE); although no information is given regarding timing pre- or post-surgery(98). The European Society for Clinical Nutrition and Metabolism (ESPEN) recommend nutritional support in patients who will be unable to eat for >5 days perioperatively(43), or those who cannot maintain >50% recommended intake for >7 days. Parenteral nutrition can be initiated as soon as possible if there is a contraindication for enteral tube feeding, such as in intestinal obstruction(43). The American Society for Parenteral and Enteral Nutrition (ASPEN) recognise starting PN preoperatively in EGS patients is unlikely to be possible and so shortening the postoperative interval of PN can be considered, but only if its duration is likely to be longer than 7 days(109). Additionally, ESPEN and ASPEN recommend the initiation of 'early enteral nutrition' (within 24-48 hours) in critically unwell patients(99,109), although it could be delayed if for one week if not high risk(110).

On recognising a patient may be malnourished, surgeons may then refer patients to a nutritional support team or dietitian for further assessment with a view to start nutritional support(307). However, it is unknown what drives surgeons' decision making to start nutritional support, and to what extent factors such as surgeon seniority or experience of intestinal failure (IF), influence the decision making process.

## Aims

This study aimed to determine the impact of key variables on surgeons' decision making regarding starting nutritional support in the emergency general surgery setting. Secondary aims included identifying whether treatment preference was associated with surgeon seniority or experience of IF.

## Methods

A discrete choice experiment (DCE) was developed to study the surgeon preferences to start nutritional support using hypothetical scenarios in experimental conditions.

### Study design

A DCE is a type of stated-preference method that uses survey methodology to elicit the preferences of participants to hypothetical scenarios(240,241). It assumes treatment preference is dependent on certain variables that can be ascribed to patient scenarios(241,351). DCEs were derived from health economics(249,352), but have been used in the healthcare setting including in relation to prostate cancer(231), breast cancer(232), major gastrointestinal surgery(233), and from a nutrition perspective(234). However, it has not been used in the context of nutrition in EGS. It can be helpful to understand decision making regarding treatment choices where there is uncertainty of best practice or individual preference is important in the decision-making process.

### Variable selection

Six variables which may influence outcome to start nutritional support were derived from relevant literature(50,301,316), informed by guidelines (43,98–101,107,109,353) and drawn from expert opinion of the study team. A summary of the selection of variables and levels is provided (**Table 5.9**), with a brief reasoning for the inclusion below.

- ***Management/ operation***

The formation of an anastomosis versus a stoma has been linked with decision making around the degree of risk surgeons are prepared to take and whether to start nutritional support(354).

- ***Albumin***

Hypoalbuminaemia is regularly used as a marker for malnutrition in both research(301) and clinical practice(316) despite guideline recommendation otherwise(43,98–101).

- ***Body mass index***

Body mass index is widely accepted as a marker of nutritional status(353). A BMI <18.5Kg/m<sup>2</sup> defines malnutrition in UK and European guidelines(43,98,106). ASPEN use a range of weight loss criteria for malnutrition(109). A low BMI (<20Kg/m<sup>2</sup> if <70 years, <22Kg/m<sup>2</sup> if >70 years),

combined with other measures, can also be criteria for being malnourished(101,106). ASPEN recognise patients with extreme low or high BMIs may be malnourished(107).

- **Unintentional weight loss**

More than 10% weight loss in 3-6 months defines malnutrition in UK guidelines(98). ESPEN criteria for malnutrition includes weight loss of 10-15% within six months(43), while ASPEN use a range of weight loss criteria for malnutrition(107). Global Leadership in Malnutrition (GLIM) guidelines criteria include more than 5% weight loss within the past six months, or more than 10% beyond six months(101).

- **Days without oral intake**

NICE recognise patients are at risk of malnutrition if patients have eaten, or are likely to eat, little or nothing for five days(98). ESPEN and ASPEN recommend the initiation of 'early EN' (within 24-48 hours) in critically unwell patients, although if not high risk it may be delayed for 5-7 days(99,109,110). Other guidelines reference reduced energy intake(43,101,107,109). These were captured by 'days without oral intake *until now*' (representing the time between symptom onset to surgical review) and 'days likely to be without oral intake *from now*' (representing the time between surgical review into the future).

**Table 5.9:** Discrete choice variables and levels

| Variable                                                      | Level 1                                | Level 2          | Level 3                                     | Level 4                 |
|---------------------------------------------------------------|----------------------------------------|------------------|---------------------------------------------|-------------------------|
| Management/<br>operation                                      | Continue<br>conservative<br>management | Adhesiolysis     | SB resection +<br>anastomosis (no<br>stoma) | SB resection +<br>stoma |
| Albumin, g/L                                                  | < 25                                   | 25-29.9          | 30-34.9                                     | <b>≥35</b>              |
| BMI, Kg/m <sup>2</sup>                                        | <18.5                                  | <b>18.5-24.9</b> | 25-29.9                                     | ≥30                     |
| Unintentional<br>weight loss, % in<br>3-6 months              | <b>0-4.9</b>                           | 5-10             | >10                                         | -                       |
| Days without oral<br>intake <u>until now</u> .                | 1-4                                    | 5-6              | ≥7                                          | -                       |
| Days likely to be<br>without oral<br>intake <u>from now</u> . | 1-4                                    | 5-6              | ≥7                                          | -                       |

Abbreviations: Body mass index (BMI); small bowel (SB)

Reference value in bold



## DCE development

Twenty-five scenarios were randomly generated using SPSS v27 Orthoplan software out of a potential 1,728 scenarios with an orthogonal design to minimise overlap(232,355). An example scenario is shown (**Figure 5.4**). The scenarios were presented to surgeons after introductory questions relating to current grade and intestinal experience. Scenario plausibility was checked with the expert panel, and no changes were made to those generated.

For each scenario, surgeons were asked to decide whether they ‘would start artificial nutritional support to meet the requirements of this patient?’ Surgeons could choose only ‘yes’ or ‘no’. While it is recognised that surgeons may want to seek an opinion, this third option was not included as a pair-wise design was considered to more closely reflect clinical practice(233). To add clinical context to the study, all scenarios were prefixed with the same introductory stem. This stem allowed both conservative and operative management to be possible. Secondly, the days since admission represent typical time points when decisions around nutritional support might usually be made.

You are doing a ward round and reviewing this patient. It is day 3 since admission, and for relevant cases, it is post-operative day 1.

### Scenario 1

|                                                       |                 |
|-------------------------------------------------------|-----------------|
| Management/ operation                                 | Conservative Mx |
| Albumin, g/L                                          | ≥35             |
| BMI, Kg/m <sup>2</sup>                                | 18.5-24.9       |
| Unintentional weight loss, % in 3-6 months            | 0-4.9           |
| Days without oral intake <u>until now</u>             | ≥7              |
| Days likely to be without oral intake <u>from now</u> | 1-4             |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

**Figure 5.4:** Scenario example

## Sample size

The minimum sample size needed for a DCE is complex. It depends on the statistical model used in the DCE analysis, an initial belief about the parameter values, the DCE design, as well as significance level (a) and statistical power level (1-b)(356). There were 4,889 general surgeons in the NHS in March 2022,

some of whom will be breast surgeons and do not participate on an EGS rota(350). Given the target population is itself relatively small, sample size calculations were deemed unhelpful. Additionally, sample sizes a little over 100 are typically adequate to model preference data(357), although it is possible with smaller samples(241). This is because analysis involves number of participants multiplied by the number of scenarios. Hence, even with a relatively small sample size of 100 participants, analysis would be on 2,500 scenarios (100 x 25). Therefore, a sample size of 100 was aimed for.

## **Ethical approval and Informed Consent**

University of Sheffield ethical approval was obtained (UREC 050436). A Participant Information Sheet was emailed to potential participants which explained the purpose and duration of the study. Implied consent was given by participants clicking on a link in the invitation email, and subsequently on another link agreeing to continue on the welcome page of the study.

## **Development and pre-testing**

The DCE was piloted among five consultant and non-consultant general surgeons to ensure face and content validity. Feedback confirmed plausible scenarios and a mean time for completion of ten minutes for the DCE section (although 15 minutes overall as it took five minutes for the survey section (study 4) of the study). Fewer scenarios per page were recommended and this was addressed in the final design.

## **Recruitment and survey administration**

Surgeons working at registrar-level or above were eligible to complete the DCE. This included surgeons in training and fellows post-certificate of completion of training, as well as SAS doctors, associate specialists, and trust grade surgeons. Surgeons working below the level of a registrar were excluded.

The 25 scenarios were transformed into a survey format for online dissemination. The final study was publicised to members of the Association of Surgeons of Great Britain and Ireland (ASGBI), for which the study had received research support. Surgeons who had completed previous studies of a similar nature were also invited, as were members of general surgical trainee- and EGS-specific groups on social media platforms. Responses were gathered using Qualtrics survey software, which also records the number of incomplete responses. Along with a click-counting URL, this enabled a response rate to be calculated.

The study opened in December 2023 for 10 weeks. There were two additional reminders to complete it and no incentives were offered. Responses were anonymous, although participants were able to leave their email if they wished to be contacted in the future, be informed of findings or avoid reminder emails. Participants were able to review answers until submission.

## **Analysis**

Descriptive analyses were performed in IBM SPSSv27. Binomial logistic regression was performed to test for associations between treatment preferences and each of the variables, with responses clustered at participant level. P values <0.05 were considered significant. Similar analysis was performed for surgeons based on seniority (consultant versus non-consultant) and experience of intestinal failure, which was self-reported and not defined. Not starting nutritional support was treated as the reference category.

## Results

### Participant results

A total of 284 responses were recorded, of which 149 were completed. One response was excluded as the surgical trainee was not a specialty trainee or consultant. The completion rate was 52.1% (148/284). Half the surgeons were consultants (50.7%, 75/148) and almost half had experience of IF (46.6%, 69/148). Ten consultants (13.3%, 10/75) worked in an intestinal failure unit. All training regions in the UK were represented, with 64/148 (43.2%) of responses from Yorkshire and Humber. A summary of the included participants has already been shown in chapter 9 (**Table 5.3**).

## Scenario results

The 148 surgeons answered 3,700 scenarios (148 x 25); there were no missing answers. In 74.4% (2,753/ 3,700) of the scenarios surgeons preferred starting nutritional support, and in 25.6% of scenarios (947/3,700), surgeons preferred not to start nutritional support. Overall, 91% (136/148) of surgeons favoured starting nutritional support in the majority of scenarios (**Figure 5.5**), with nutritional support being favoured in 23 of the 25 scenarios (**Table 5.10**). However, there was treatment uncertainty for 14/25 scenarios, defined as less than 85% of surgeons choosing the same treatment preference (scenarios 1, 3, 4, 5, 8, 9, 11, 12, 13, 15, 19, 20, 21, 25). These included scenarios containing variables 1-4 'days without oral intake until now' (7/10 scenarios) and 1-4 'days likely to be without oral intake from now' (9/10 scenarios), and 7/10 scenarios (70%) of scenarios containing 5-10% unintentional weight loss.

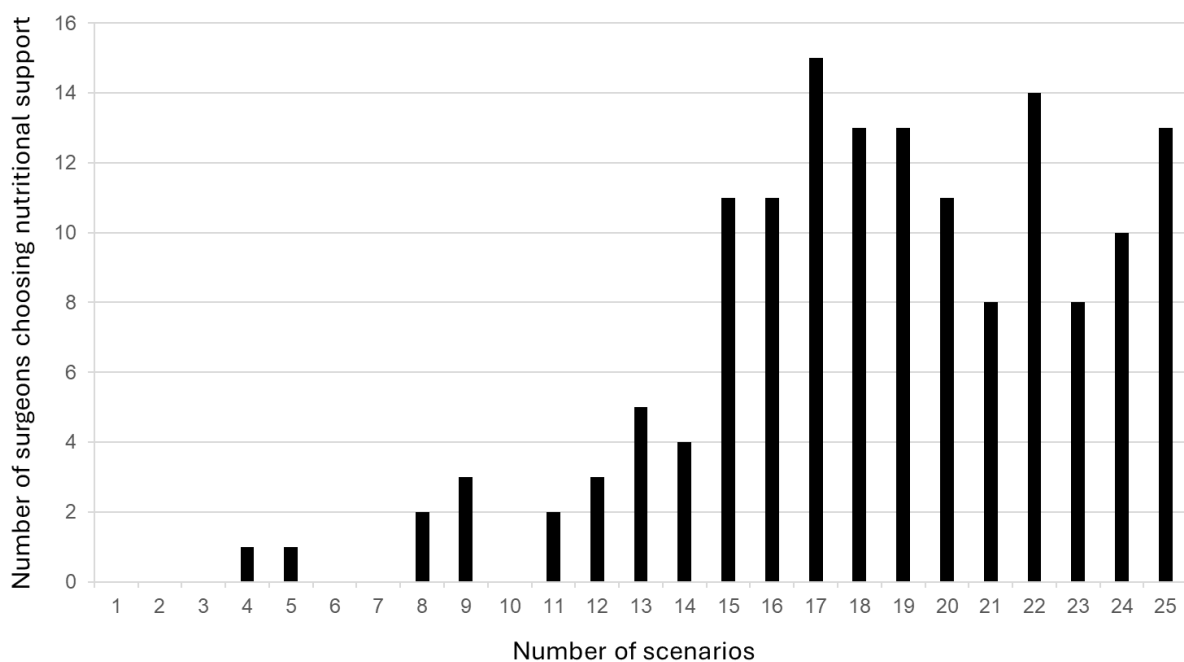


**Figure 5.5:** Preference for nutritional support

**Table 5.10:** Results by scenario

| Scenario | Diagnosis                        | Albumin (g/L) | BMI (Kg/m <sup>2</sup> ) | Unintentional weight loss | DWOI until now | Days likely to be WOI from now | For nutritional support | Not for nutritional support |
|----------|----------------------------------|---------------|--------------------------|---------------------------|----------------|--------------------------------|-------------------------|-----------------------------|
| 1        | SB resection and stoma           | >35           | 18.5-24.9                | 0-4.9                     | >7             | 1-4                            | 60.8 (90)               | 39.2 (58)                   |
| 2        | SB resection and anastomosis     | 30-34.9       | <18.5                    | 0-4.9                     | 1-4            | >7                             | 95.9 (142)              | 4.1 (6)                     |
| 3        | Continue conservative management | 30-34.9       | 25-29.9                  | 0-4.9                     | >7             | 1-4                            | 75.0 (111)              | 25.0 (37)                   |
| 4        | SB resection and anastomosis     | <25           | >30                      | 0-4.9                     | 5-6            | 1-4                            | 69.6 (103)              | 30.4 (45)                   |
| 5        | Continue conservative management | <25           | <18.5                    | 0-4.9                     | 1-4            | 1-4                            | 58.8 (87)               | 41.2 (61)                   |
| 6        | Continue conservative management | 30-34.9       | 18.5-24.9                | >10                       | 5-6            | 5-6                            | 91.9 (136)              | 8.1 (12)                    |
| 7        | Continue conservative management | <25           | >30                      | 0-4.9                     | 5-6            | 5-6                            | 86.5 (128)              | 13.5 (20)                   |
| 8        | Adhesiolysis                     | 30-34.9       | <18.5                    | 5-10                      | 5-6            | 1-4                            | 64.9 (96)               | 35.1 (52)                   |
| 9        | SB resection and stoma           | 25-29.9       | <18.5                    | 0-4.9                     | 1-4            | 5-6                            | 76.4 (113)              | 23.6 (35)                   |
| 10       | Adhesiolysis                     | <25           | <18.5                    | 5-10                      | >7             | 5-6                            | 98.6 (146)              | 1.4 (2)                     |
| 11       | SB resection and anastomosis     | >35           | 25-29.9                  | 5-10                      | 1-4            | 5-6                            | 62.2 (92)               | 37.8 (56)                   |
| 12       | SB resection and stoma           | <25           | <18.5                    | 5-10                      | 5-6            | 1-4                            | 74.3 (110)              | 25.7 (38)                   |
| 13       | Continue conservative management | 25-29.9       | <18.5                    | >10                       | 1-4            | 1-4                            | 53.4 (79)               | 46.6 (69)                   |
| 14       | Continue conservative management | >35           | <18.5                    | 0-4.9                     | 5-6            | 5-6                            | 87.8 (130)              | 12.2 (18)                   |
| 15       | SB resection and anastomosis     | 25-29.9       | 18.5-24.9                | 5-10                      | 5-6            | 1-4                            | 57.4 (85)               | 42.6 (63)                   |
| 16       | Adhesiolysis                     | <25           | 18.5-24.9                | 0-4.9                     | 1-4            | >7                             | 90.5 (134)              | 9.5 (14)                    |
| 17       | Adhesiolysis                     | >35           | >30                      | >10                       | 1-4            | 1-4                            | 14.9 (22)               | 85.1 (126)                  |
| 18       | SB resection and anastomosis     | <25           | <18.5                    | >10                       | >7             | 5-6                            | 98.6 (146)              | 1.4 (2)                     |
| 19       | Continue conservative management | <25           | 18.5-24.9                | 5-10                      | 1-4            | 5-6                            | 78.4 (116)              | 21.6 (32)                   |
| 20       | SB resection and stoma           | 30-34.9       | >30                      | 5-10                      | 1-4            | 5-6                            | 58.1 (86)               | 41.9 (62)                   |
| 21       | Continue conservative management | <25           | 25-29.9                  | 5-10                      | 1-4            | 1-4                            | 29.1 (43)               | 70.9 (105)                  |
| 22       | Continue conservative management | >35           | <18.5                    | 5-10                      | 5-6            | >7                             | 98.6 (146)              | 1.4 (2)                     |
| 23       | Continue conservative management | 25-29.9       | >30                      | 5-10                      | >7             | >7                             | 98.0 (145)              | 2.0 (3)                     |
| 24       | SB resection and stoma           | <25           | 25-29.9                  | >10                       | 5-6            | >7                             | 99.3 (147)              | 0.7 (1)                     |
| 25       | Adhesiolysis                     | 25-29.9       | 25-29.9                  | 0-4.9                     | 5-6            | 5-6                            | 81.1 (120)              | 18.9 (28)                   |

n = 148 surgeons. Abbreviations: Body mass index (BMI); days without oral intake (DWOI); without oral intake (WOI); small bowel (SB)

## Influence of variables

Three variables demonstrated an independently significant association with a preference for starting nutritional support at all levels on binominal logistic regression (Table 5.11,

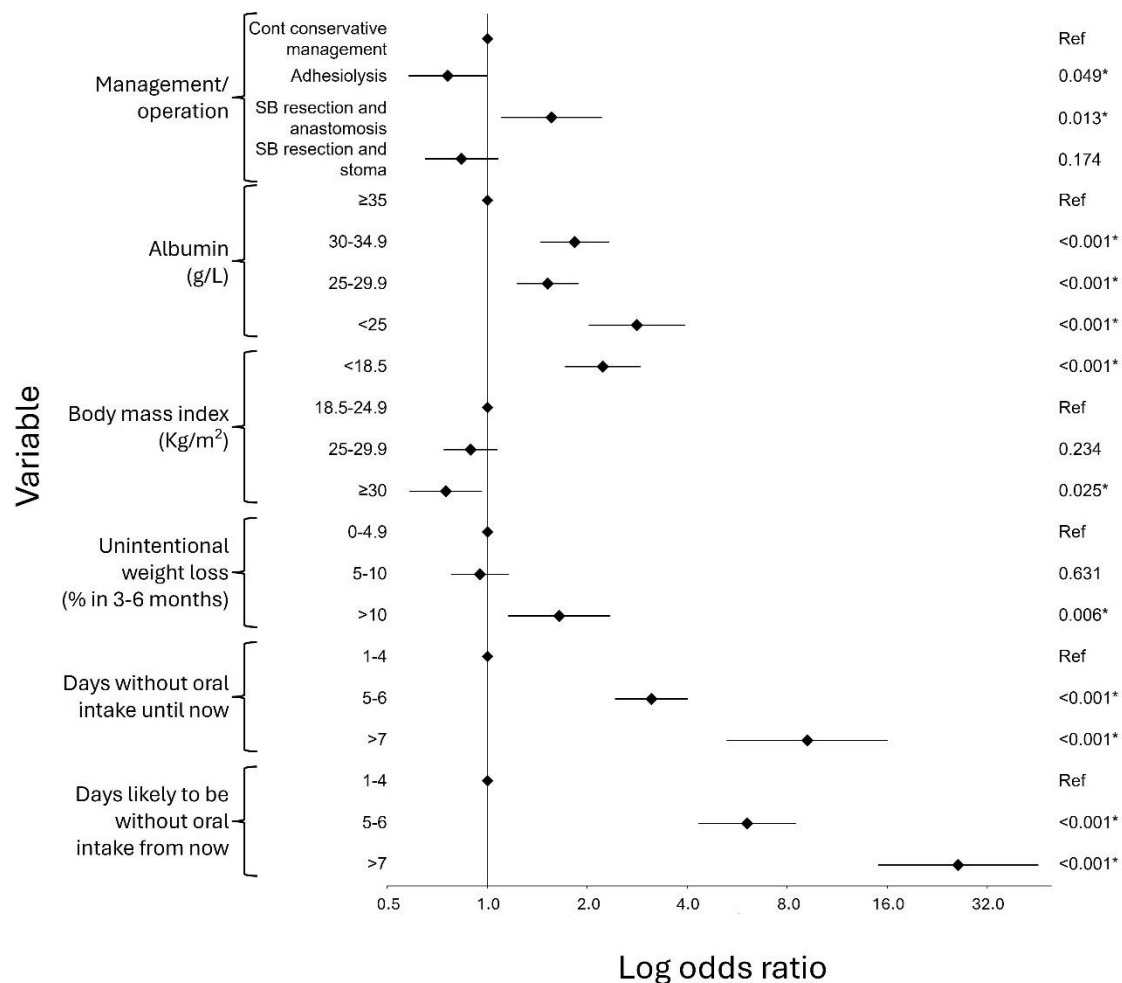


**Figure 5.6).** These included hypoalbuminaemia, ‘days without oral intake until now’ and ‘days likely to be without oral intake from now’. There was an increased preference for starting nutritional support for each successive time period of days without oral intake (both ‘until now’ or ‘from now’).

Three variables offered a mixed picture. Firstly, in comparison to the reference value of continuing conservative management, scenarios with a small bowel resection and anastomosis were significantly associated with preference for starting nutritional support. The contrary was true for adhesiolysis alone; it was significantly associated with a preference for not starting nutritional support. A small bowel resection and stoma was associated with a preference for not starting nutritional support, but this was not significant. Secondly, incremental increases in BMI were associated with a preference for not starting nutritional support. Consequently, scenarios with which featured a BMI less than 18.5 Kg/m<sup>2</sup> were significantly associated with a preference for starting nutritional support, yet it was not

for scenarios with a BMI more than 30Kg/m<sup>2</sup>. Finally, >10% unintentional weight loss in 3-6 months was associated with a preference to start nutritional support. This was not seen in scenarios with only 5-10% weight loss.



**Table 5.11:** Influence of DCE variables over treatment choice

| Variable                                              | Level                            | OR     | 95% C.I.<br>(lower) | 95% C.I.<br>(upper) | p-value |
|-------------------------------------------------------|----------------------------------|--------|---------------------|---------------------|---------|
| <b>Management/<br/>operation</b>                      | Continue conservative management | Ref    | -                   | -                   | -       |
|                                                       | Adhesiolysis                     | 0.761  | 0.580               | 0.999               | 0.049*  |
|                                                       | SB resection + anastomosis       | 1.563  | 1.102               | 2.216               | 0.013*  |
|                                                       | SB resection + stoma             | 0.838  | 0.650               | 1.082               | 0.174   |
| <b>Albumin (g/L)</b>                                  | ≥35                              | Ref    | -                   | -                   | -       |
|                                                       | 30-34.9                          | 1.837  | 1.447               | 2.331               | <0.001* |
|                                                       | 25-29.9                          | 1.523  | 1.229               | 1.886               | <0.001* |
|                                                       | <25                              | 2.826  | 2.024               | 3.947               | <0.001* |
| <b>Body mass index (Kg/m<sup>2</sup>)</b>             | 18.5-24.9                        | Ref    | -                   | -                   | -       |
|                                                       | <18.5                            | 2.232  | 1.715               | 2.906               | <0.001* |
|                                                       | 25-29.9                          | 0.893  | 0.740               | 1.077               | 0.234   |
|                                                       | ≥30                              | 0.751  | 0.584               | 0.965               | 0.025*  |
| <b>Unintentional weight loss (% in 3-6 months)</b>    | 0-4.9                            | Ref    | -                   | -                   | -       |
|                                                       | 5-10                             | 0.952  | 0.778               | 1.165               | 0.631   |
|                                                       | >10                              | 1.651  | 1.159               | 2.351               | 0.006*  |
| <b>Days without oral intake until now</b>             | 1-4                              | Ref    | -                   | -                   | -       |
|                                                       | 5-6                              | 3.126  | 2.428               | 4.024               | <0.001* |
|                                                       | >7                               | 9.200  | 5.262               | 16.084              | <0.001* |
| <b>Days likely to be without oral intake from now</b> | 1-4                              | Ref    | -                   | -                   | -       |
|                                                       | 5-6                              | 6.064  | 4.317               | 8.519               | <0.001* |
|                                                       | >7                               | 26.171 | 15.022              | 45.595              | <0.001* |

n = 148 surgeons. \*Significant results

Abbreviations: confidence intervals (CI); odds ratio (OR); small bowel resection (SB).

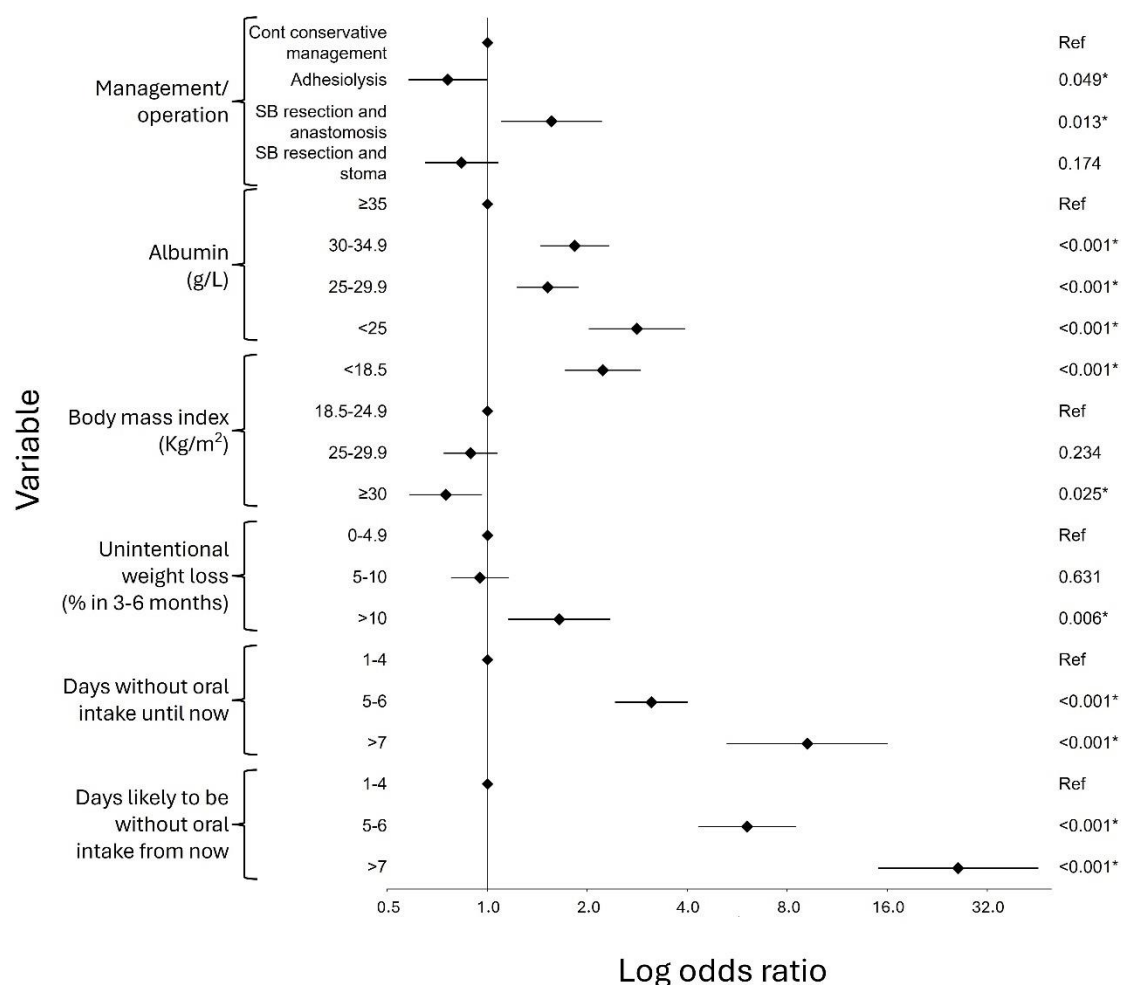


**Figure 5.6:** Forest plot of log odds ratios with 95% confidence intervals for each of the different attributes in the binary logistic regression analysis

## Influence of surgeon seniority

Whilst consultants favoured starting nutritional support (77.7%; 1443/1875) more often than non-consultants (71.8%; 1310/1825), there was no significant association with surgeon seniority (OR 1.406, 95% CI 0.936–2.114;  $p = 0.100$ ) (**Table 5.12**). However, there was a general trend for increasing preference for nutritional support as surgeons progressed through training (**Table S34**). There were only two scenarios where consultants preferred to start nutritional support and non-consultants preferred not to (scenarios 13 and 15, **Table S34**). In nine scenarios, there was a greater than 5% difference in preference for nutritional support between consultants and non-consultants (scenarios 5, 8, 11, 13, 14, 15, 17, 19, 21).

## Influence of intestinal failure experience

Consultant surgeons working in an IF unit had a greater preference for starting nutritional support (80.8%; 202/250) than consultants that do not work in an IF unit (76.4%; 1241/1625) (**Table S35**). Also, surgeons with self-reported intestinal failure experience (75.7%; 1305/1725) were marginally more in favour of starting nutritional support than surgeons without experience (73.3%; 1448/1975) (Table S3). However, experience of IF did not confer any statistical significance with starting nutritional support (OR 1.093, 95% CI 0.732–1.631;  $p = 0.663$ ) (**Table 5.12**).

Of note, there were six scenarios with five or more percentage points difference (and up to almost 40 percentage points in one scenario) where surgeons working in an IF unit would initiate nutritional support but surgeons not at an IF unit would not (scenarios 5, 11, 16, 19, 20, 21, **Table S35**). In contrast, there was only one scenario (scenario 9) with more than five percentage points difference where surgeons at non-IF units were more likely to initiate nutritional support compared to surgeons at IF units. A similar trend, but with a lower percentage point difference, is seen when comparing surgeons with IF experience to those without IF experience. Surgeons with IF experience would start nutritional support more than surgeons without in scenarios 5, 11, 13, 15, 19, 20 and 21; and the converse is true for scenario 4 (**Table S36**).

**Table 5.12:** Influence of surgeon seniority and IF experience over treatment choice

| Variable      | Level          | OR    | 95% C.I. (lower) | 95% C.I. (upper) | p-value |
|---------------|----------------|-------|------------------|------------------|---------|
| Seniority     | Non-consultant | Ref   | -                | -                | -       |
|               | Consultant     | 1.406 | 0.936            | 2.114            | 0.100   |
| IF experience | No experience  | Ref   | -                | -                | -       |
|               | Experience     | 1.093 | 0.732            | 1.631            | 0.663   |

n = 148 surgeons. Abbreviations: Confidence intervals (CI); odds ratio (OR).

## Discussion

This study confirmed that many variables influence the decision to start nutritional support in emergency general surgical patients. However, decision making is not significantly influenced by surgeon seniority or experience of intestinal failure.

Starting nutritional support was significantly associated with 'days without oral intake until now' and 'days likely to be without oral intake from now'. Obtaining information about oral intake relies on a thorough patient history and contemporaneous medical records. Of all variables, 'days likely to be without oral intake from now' influenced decision making most. This suggests surgeons form a strategic nutritional plan based on likely prognosis, though predicting this can be difficult and often nuanced. Clinically, patients may have been vomiting, have undergone a trial period of conservative management with bowel rest and had little/ no oral intake, have a prolonged operation, occasionally remain intubated and ventilated post-operatively, develop an ileus or may be slow to 'build up' to normal diet. Taken together – 'days without oral intake until now' and 'days likely to be without oral intake from now' – it is often the case for patients to have an extended period of time with little or no nutritional intake. Recording this time frame, recognising patients are not meeting their nutritional needs and developing a clear plan to correct this is required by surgeons. Nutritional status is a dynamic process, and patients may become malnourished during their hospital stay if not so on admission(50). Repeated screening and assessments are required to identify it early and are recommended(98,106). However, it was not possible to capture these data without substantially changing the nature of the study.

Any degree of hypoalbuminaemia influenced the decision to start nutritional support; the more severe the hypoalbuminaemia, the more likely nutritional support was to be started. It is an independent prognostic marker of mortality(94,267,321). Hypoalbuminaemia is common but is not directly related to nutritional status in the acute setting where it typically behaves as a negative acute phase marker(25,26). Albumin was included as a key variable as we have previously shown it remains regularly used as a nutrition marker in both research and clinical practice(301,316), despite guidelines recommending otherwise(43,98–101). While surgeons may have interpreted hypoalbuminaemia in this study from either perspective, the scenarios stated it was 'day 3 since admission' and clearly represented an acute presentation. Any hypoalbuminaemia was unlikely to be related to malnutrition and more likely related to another cause such as the degree of inflammation/ sepsis or disease burden. As such, it is surprising hypoalbuminaemia influenced decision making regarding starting nutritional

support as was shown in this study. More work is required to educate surgeons of this and change practice.

Body mass index is a commonly used, albeit quite crude, measure of nutritional status. This study found that a BMI  $<18.5\text{Kg/m}^2$  positively influenced decision making with a view to start nutritional support. In contrast, a BMI  $25\text{--}29.9\text{Kg/m}^2$  was less likely to receive nutritional support (though not significant), and a BMI  $>30\text{Kg/m}^2$  was significantly associated with not starting nutritional support. This may be related to how surgeons perceive what being malnourished means. It is easy to 'see' malnutrition in the form of underweight patients, while it can be hidden in overweight and obese patients(69,358). Overweight and obese patients may be considered to tolerate nutritional loss before it deleteriously impacts outcomes, and so nutritional support is not needed. However, there is an increasing overweight and obese population(108), and malnutrition may be missed in this cohort with potentially poor outcomes(104,326–328).

A preference to initiate nutritional support was significantly associated with more than 10% unintentional weight loss in 3-6 months. This is reassuring as it is a key criteria to diagnose malnutrition in UK guidelines(98), and similar ranges are provided in other guidelines(43,101,107). However, on closer inspection of scenarios where there was a difference in treatment preference between 1) consultant surgeons working at IF centres compared to those that do not (**Table S35**), and 2) all surgeons with IF experience compared to those without (**Table S36**), many of these scenarios involved a hypoalbuminaemia, a 5-10% weight loss and 1-4 days without oral intake. A grounding in nutrition may afford surgeons the ability to observe for 'soft markers' of malnutrition, while those that have less exposure rely on 'objective' markers like albumin. This may explain why any level of

hypoalbuminaemia influences decision making to a greater degree than 5-10% weight loss (

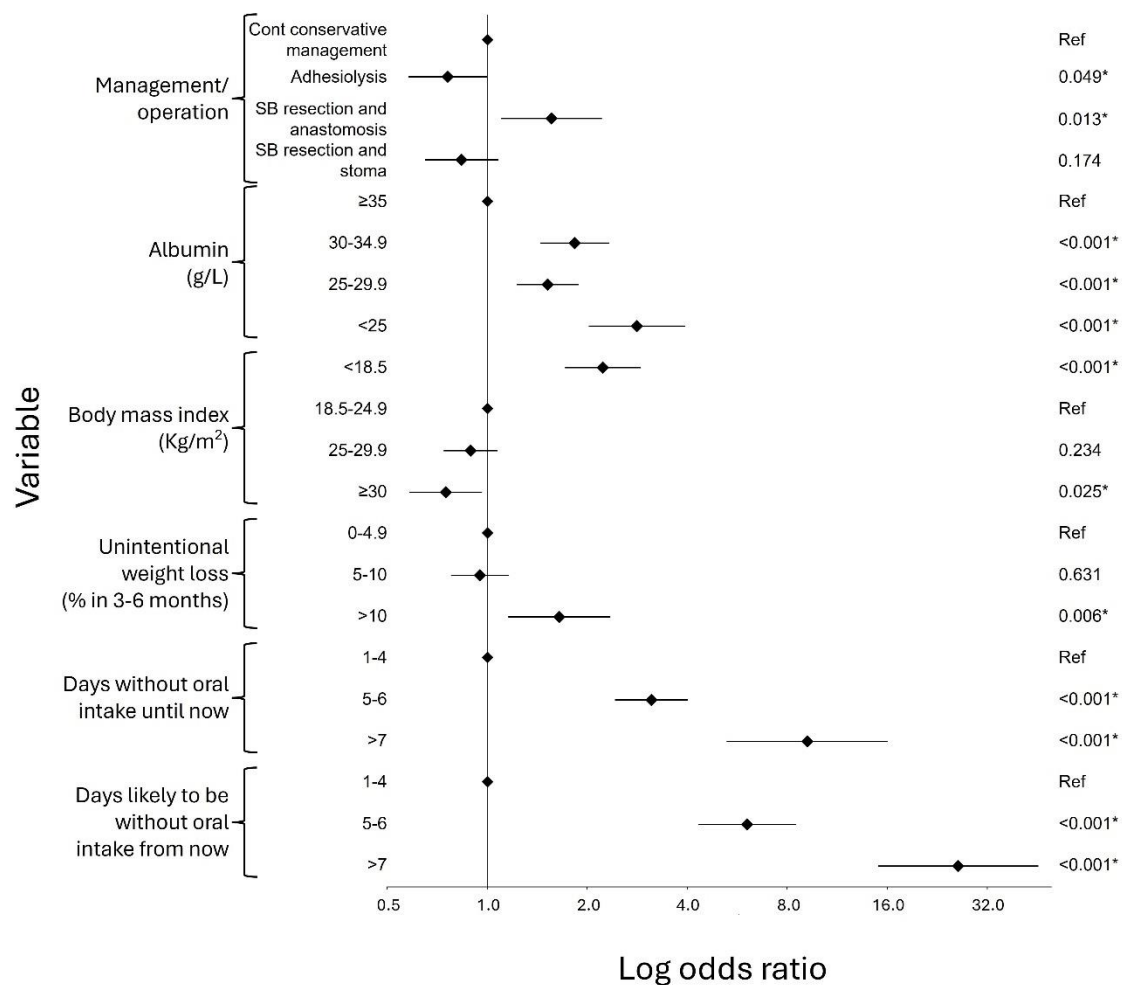


Figure 5.6).

Finally, the overall management and operation performed influenced whether surgeons would start nutritional support. An anastomosis meant surgeons were significantly more likely to start nutritional support, whilst they were less so if there was a stoma or there was adhesiolysis alone. The formation of an anastomosis has been linked with decision making around the degree of risk surgeons are prepared to take(354). Surgeons may to start nutritional support to 'protect' it, especially with a proximal anastomosis where the alternative of a high stoma is not a sensible option for the patient. Alternatively, surgeons may consider these patients will take longer to establish oral intake, and so nutritional support is likely to be required. While forming an anastomosis and 'days likely to be without oral intake from now' may be linked, this study showed they independently increased the likelihood of starting nutritional support. However, patients who have undergone an adhesiolysis or had a stoma formed may also have had little or no nutritional intake for some time. Their nutritional recovery may be slower than anticipated, and nutritional support may be warranted in these patients too. This study

confirms decision making by surgeons around nutritional support are made in the context of whether the patient has an anastomosis or a stoma following a bowel resection. These factors might be used as stratification or minimisation variables in future randomised trials of nutrition. Funding bodies may consider a commissioned call to inform nutritional support strategies in this setting.

## **Strengths of the study**

This DCE benefits from capturing 3,700 surgeon responses to a single question, 'would you start artificial nutritional support to meet the requirements of this patient?' Participants across all grades of seniority, experience of intestinal failure and training region completed the study. The scenarios were based on six key variables drawn from the literature and guidelines, allowing us to understand the relative contribution of variables to decision making. While each influenced decision making, caution should be exercised in using any in isolation when deciding if patients require nutritional support.

## **Limitations of the study**

There are limitations to this study. Firstly, self-selection bias may exist. Surgeons favoured starting nutritional support in 74.4% of scenarios, far more than the 14.8% seen clinically(50). However, this difference may represent the ideal scenario versus practical circumstances, or may reflect the true appetite of surgeons' preference for wider use of nutritional support. Experience of intestinal failure had an open definition and was determined by participants, as was the mode of artificial nutritional support.

Hypothetical scenarios may lose some clinical context. While steps were taken to mitigate this by providing an informative clinical stem, they do not capture the dynamic situation encountered on a day-to-day ward round. Further, surgeons may wish to have started nutritional support but know it may not be enough 'to meet the requirements of the patient'. This could have led participants, particularly those with a nutrition interest, to answer erroneously (i.e. they would start nutritional support ordinarily but not at the level of meeting requirements, and so answer 'no' in one of our scenarios). The results from this study rebut this because surgeons with IF experience started nutritional support more than those without IF experience. Additionally, the clinical stem was related to small bowel obstruction. While this allowed the 'management/ operation' variable to be investigated as a potential influencer of decision making around nutritional support, there is variation nationally and internationally in the management of this surgical emergency(49,359). For this reason,

the study was limited to one nationality alone. However it would be interesting to investigate whether the results are consistent internationally.

Arguably, 1-4 'days without oral intake until now' and 1-4 'days likely to be without oral intake from now' may mean a patient has no oral intake for 2-8 days; a considerably wide range. Other variables may also influence the decision making process such as access to nutritional support. However, splicing days without oral intake further or including more variables would dramatically increase the number of scenarios required and participant burden.

Finally, while surgeons may be proponents of starting nutritional support, decisions are rarely made in isolation. Other highly trained healthcare professionals including dietitians and gastroenterologists form part of the nutrition multidisciplinary team. Not all centres proclaim to having a nutrition support team(158,316). A comparative study investigating interprofessional differences in decision making that may inform policy pathways.

## **Implications for policy makers**

Firstly, this study has shown several variables influence decision making to start nutritional support in EGS. Policy makers need to consolidate and ensure consistency across guidelines. Strategies to ensure implementation of these, perhaps by using national datasets such as the National Emergency Laparotomy Audit database or creating a new 'small bowel obstruction database', need to be considered. In particular, clarity needs to be provided for surgeons regarding use of albumin as a nutritional marker, as well as it being acknowledged that overweight and obese patients can be malnourished and may require nutritional support also. Surgeons should consider 'soft' nutrition indices such as small degrees of weight loss as part of their decision making process too.

Secondly, this DCE indicates an appetite for nutritional support which is not echoed clinically in national cohort studies(50). Policy makers should investigate how access to nutritional support can be improved to meet this demand. Studies suggest this is limited by resources and funding(316).

## **Implications for researchers**

This study confirms decision making by surgeons around nutritional support are made in the context of whether the patient has an anastomosis or a stoma following a bowel resection. These might be



used as stratification or minimisation variables in future randomised trials of nutrition. Funding bodies may consider a commissioned call to inform nutritional support strategies in this setting.

## Conclusion

Variables derived from guidelines informed the development of hypothetical scenarios upon which surgeons were asked whether they would start nutritional support or not. This study showed many variables influence the decision to nutritional support in EGS, but surgeon and IF experience do not. Days likely to be without oral intake influenced decision making most.

## Chapter summary

### Paper 3

- This paper has been published in Colorectal Disease. It aimed to explore how consultant surgeons identify malnutrition in EGS patients and the barriers to nutritional assessment and intervention. Additionally, it aimed to identify whether practice was reflective of different institutional setting.
- Eighteen surgeons were purposively recruited from district general hospitals, teaching hospitals and intestinal failure units to undertake online semi-structured interviews.
- Three themes summarise how consultant surgeons identify malnourished EGS patients. These were: The Surgeon (knowledge, experience, planning ahead), The Patient (selection, composition, clinical progress, operative strategy) and The Institution (collaboration, the extended surgical team).
- Three themes summarise the barriers consultant surgeons experience when identifying malnourished EGS patients. These were: The Surgeon (understanding, culture, ownership, time constraints), The Institution (provision, staffing, conflict, hospital setting) and The Wider Context (research, external factors).
- Decision making around forming an anastomosis (risk taking, site of anastomosis) and nutritional support (timing, delivery pathway) was an emerging theme.
- Surgeons that worked in intestinal failure units described easier access to nutritional support and this seemed to influence their intra-operative and nutritional management decisions.

### Paper 4

- The paper has been submitted to the RCS Annals for publication and is currently subject to peer review. It aimed to characterise the awareness, practice and training of general surgeons in identifying malnutrition in EGS. Differences according to surgeon seniority and experience of IF were also assessed.
- A total of 148/289 (52.1%) surgeons completed the study, with an approximately equal distribution of non-consultants to consultants, and surgeons with experience of IF and those without. This same population also completed study 5.
- Almost all surgeons recognised malnutrition can affect surgical outcomes and consider it an important skill to possess. This was irrespective of grade or experience of IF.
- Surgeons consider it their responsibility to identify malnourished EGS patients but there is a broad lack of confidence in doing so. Notably, surgeons with IF experience felt more

responsible and significantly more confident to identify malnourished patients than surgeons without IF experience. This may reflect why they were significantly more likely to screen for malnutrition than surgeons without IF experience.

- Reduced oral intake until now, followed by reduced oral intake from now and an end of the bed 'clinical impression' were the main approaches surgeons used to identify malnourished EGS patients.
- The majority of surgeons reported not receiving any nutritional training, irrespective of surgeon seniority or experience of intestinal failure. Much training results from other allied health professionals and previous patient cases. Two-thirds of surgeons would like a short course or specific local training in nutritional assessment/ management.

## Paper 5

- The paper has been submitted to Colorectal Disease for publication and is currently subject to peer review. It aimed to determine surgeon preference to start nutritional support in the emergency setting, and identify any differences between surgeon and IF experience.
- Six variables (management/ operation, albumin, BMI, unintentional weight loss, days without oral intake until now, days without oral intake from now) which may influence outcome to start nutritional support were used to create 25 scenarios with an orthogonal design to minimise overlap.
- 148 surgeons answered 3,700 scenarios (148 x 25). Overall, consultants and non-consultant surgeons preferred to start nutritional support in 74.4% of scenarios (2,753/ 3,700).
- Days likely to be without oral intake influenced decision making most. There was an increased preference for starting nutritional support for each successive time period of days without oral intake (both 'until now' or 'from now').
- Albumin and BMI influenced decision making to start nutritional support. Each degree of hypoalbuminaemia significantly influenced the likelihood of surgeons starting nutritional support. Nutritional support was significantly less likely to be started in obese patients compared to those with a normal BMI, yet more likely to be started in underweight patients.
- Scenarios with a small bowel resection and anastomosis were significantly associated with preference for starting nutritional support while scenarios featuring adhesiolysis or a small bowel resection and stoma were not.
- Surgeon seniority nor experience of IF did not significantly influence the decision to start nutritional support.

## 6 Thesis findings summary

This thesis used mixed methods research methodology to investigate the similarities/ differences in how malnutrition is identified in emergency general surgery. This chapter systematically discusses the findings of all five studies in relation to one another (**Figure 6.1**). It aims to bring together the results of the quantitative and qualitative methods to triangulate the relevant findings and enable a broader understanding of how and why surgeons identify malnutrition in EGS. A summary of these key findings are mapped according to the thesis objectives is provided (**Table 6.1**). A reminder of the thesis research questions and objectives is provided:

### 6.1 Research questions

- **Research question 1:** ‘What similarities/ differences exist in how surgeons identify malnutrition in emergency general surgery?’
- **Research question 2:** ‘If there are differences in how surgeons identify malnutrition in emergency general surgery, why do they exist?’

### 6.2 Objectives

- **Objective 1:** To describe how malnutrition is defined in the EGS research literature.
- **Objective 2:** To describe how malnutrition is identified in current practice in NELA-eligible patients.
- **Objective 3:** To explore how consultants that undertake EGS identify malnutrition and the barriers they encounter.
- **Objective 4:** To establish how senior decision makers identify malnutrition in EGS, how they were trained and how it may be improved.
- **Objective 5:** To determine the impact of key variables on senior decision makers’ treatment preferences to start nutritional support for EGS patients.
- **Objective 6:** To understand if surgeon seniority or experience of intestinal failure influences surgeon decision making regarding starting nutritional support.

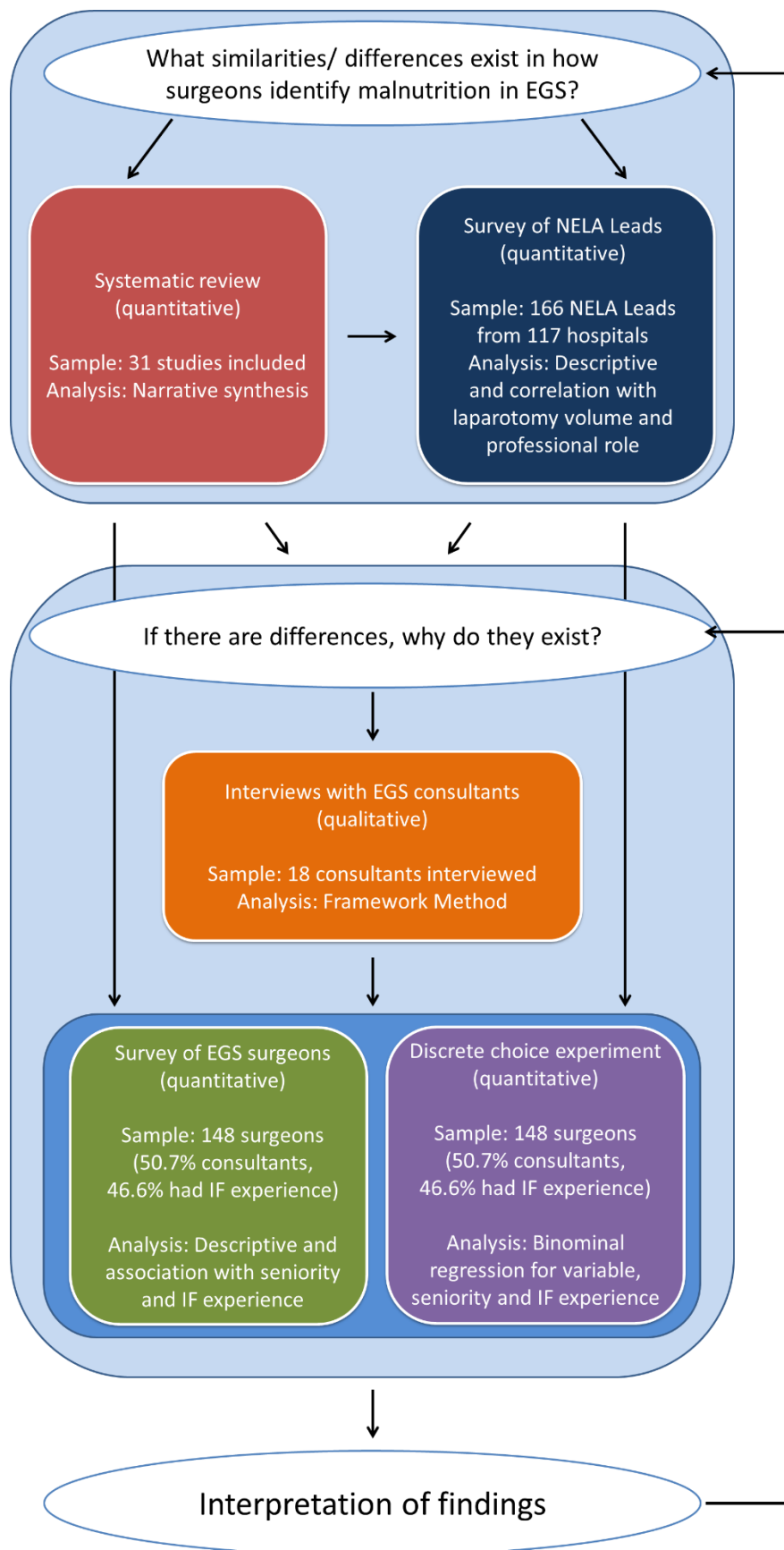


**Figure 6.1:** Schema for interpretation and triangulation of individual studies

**Table 6.1:** Key findings mapped according to thesis objectives

| Objective and Key findings                                                                                                                                            | Paper 1 | Paper 2 | Paper 3 | Paper 4 | Paper 5 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|---------|---------|---------|
| <b>Objective 1. To describe how malnutrition is defined in the EGS research literature.</b>                                                                           |         |         |         |         |         |
| 1. Malnutrition is defined by a variety of methods in research.                                                                                                       | x       |         |         |         |         |
| 2. The processes used to identify malnutrition rarely presents screening and assessment as distinct stages.                                                           | x       |         |         |         |         |
| <b>Objective 2. To describe how malnutrition is identified in current practice in NELA-eligible patients.</b>                                                         |         |         |         |         |         |
| 1. Screening and assessment for malnutrition are not routine.                                                                                                         |         | x       |         | x       |         |
| 2. Multiple healthcare professionals are involved in identifying malnourished EGS patients.                                                                           |         | x       | x       | x       |         |
| 3. Multiple healthcare professionals are involved in managing malnourished EGS patients.                                                                              |         |         | x       | x       |         |
| 4. There is a lack of organisational support for malnourished EGS patients.                                                                                           |         | x       | x       | x       |         |
| 5. Surgeons are not confident at identifying and managing malnourished EGS patients.                                                                                  |         | x       | x       | x       |         |
| <b>Objective 3. To explore how consultants that undertake EGS identify malnutrition and the barriers they encounter.</b>                                              |         |         |         |         |         |
| 1. The Surgeon: a lack of knowledge and understanding results from time-short, poorly trained surgeons and outdated surgical culture.                                 |         | x       | x       | x       |         |
| 2. The Surgeon: surgeons routinely seek advice, but this is not always accepted and conflict ensues.                                                                  | x       |         | x       | x       |         |
| 3. The Patient: Malnutrition is identified using an assortment of methods, but screening with MUST is dubious.                                                        | x       | x       | x       | x       |         |
| 4. The Institution: being an IF surgeon or working in an IF unit is different to not being an IF surgeon or not working in an IF unit.                                |         |         | x       | x       |         |
| 5. The Wider context: there is a need for a well-designed nutrition in EGS trial.                                                                                     | x       | x       | x       | x       |         |
| 6. Malnourished patients are more likely to be given a stoma, but less likely to be started on nutritional support.                                                   |         |         | x       |         | x       |
| <b>Objective 4. To establish how senior decision makers identify malnutrition in EGS, how they were trained and how it may be improved.</b>                           |         |         |         |         |         |
| 1. Multiple measures are used to identify malnourished patients in EGS in clinical practice.                                                                          | x       | x       | x       | x       |         |
| 2. Surgeons want better nutrition training and national surgical societies can help facilitate it.                                                                    |         |         | x       | x       |         |
| <b>Objective 5. To determine the impact of key variables on senior decision makers' treatment preferences to start nutritional support for EGS patients.</b>          |         |         |         |         |         |
| 1. Hypoalbuminaemia is misused as a marker for malnutrition and influences operative and clinical decision making.                                                    | x       | x       | x       | x       | x       |
| 2. Malnourished patients may not be receiving the appropriate management if they are obese.                                                                           | x       | x       | x       | x       | x       |
| 3. Weight loss is a marker of malnutrition for senior surgeons and those with experience of IF.                                                                       |         |         | x       | x       | x       |
| 4. Oral intake influences the decision to start nutritional support more than any other variable.                                                                     | x       |         | x       | x       | x       |
| <b>Objective 6. To understand if surgeon seniority or experience of intestinal failure influences surgeon decision making regarding starting nutritional support.</b> |         |         |         |         |         |
| 1. The decision to start nutritional support in EGS does not appear to be influenced by surgeon seniority.                                                            |         |         | x       | x       | x       |
| 2. The decision to start nutritional support in EGS does not appear to be influenced by experience of IF.                                                             |         |         | x       | x       | x       |

## 6.3 Objectives and findings

**Objective 1: To describe how malnutrition is defined in the EGS research literature.**

**Finding 1: Malnutrition is defined by a variety of methods in research.**

Paper 1 found that a definition of malnutrition was provided in only 75% of studies (8,261–266,268–276,279–285). On the surface, this may appear satisfactory, however a range of methods were used. This may reflect the lack of consistency within guidelines or underscore a lack of understanding among researchers regarding what malnutrition is. The definitions could be mapped to a broad set of core areas including a patient history, clinical examination, blood (laboratory) values, disease criteria, functional tests and formulae used to ‘calculate’ the likelihood of malnutrition.

BMI was the most commonly used criteria to define malnutrition as either a primary or secondary marker of nutritional status, or as a key component of a nutritional tool, in 64.5% (n = 20) studies. Serum albumin was used as the same in 58.1% (n = 18) studies.

**Finding 2:**

**The processes used to identify malnutrition rarely presents screening and assessment as distinct stages.**

Paper 1 identified only three studies had used a nutritional screening tool followed by an assessment(8,260,279). This two-step process is recommended by the British Dietetic Association(54) and The Academy of Nutrition and Dietetics(55). Nutrition screening is often quick and identifies patient that may be at risk, while a nutrition assessment is a fuller and more comprehensive evaluation performed by a trained professional(101). An absence of the two-step process prevents effective comparison across trials. Again, it may represent researchers' lack of understanding about how malnutrition should be identified.



**Objective 2:** To describe how malnutrition is identified in current practice in NELA-eligible patients.

**Finding 1:** Screening and assessment for malnutrition are not routine.

Paper 2 demonstrated extremely low rates of screening (42/166; 25.3%) and assessment (26/166; 15.7%) for malnutrition pre-operatively. Screening (96/166; 57.8%) and assessment (82/166; 49.4%) were performed more regularly post-operatively. Paper 4 revealed 66.2% of clinicians screen and/ or assess for malnutrition in EGS patients all the time (98/148). This means one third of patients may be malnourished and not be treated in an appropriate or timely manner.

**Finding 2:**

**Multiple healthcare professionals are involved in identifying malnourished EGS patients.**

Paper 4 showed almost two-thirds of surgeons (64.9%, 96/148) felt primarily responsible for identifying malnutrition in EGS patients. There was an even distribution between consultants and non-consultants, but a slight preponderance towards surgeons without IF experience feeling primarily responsible (67.1%, 53/79) compared to those with IF experience (62.3%, 43/69). Where participants did not feel responsible, dietitians were considered to fulfil the role.

However in practice, screening is most frequently performed pre-operatively by nurses (56.9%, 70/123) and post-operatively by dietitians (27.2%, 85/312) (Paper 2). Assessment of malnutrition is performed by surgeons and dietitians equally at 23.8% (48/202) and 22.3% (45/202), respectively. Post-operatively, assessment for malnutrition is undertaken mainly by dietitians at 32.8% (100/305).

These differences may be explained by a conflation of terminology between screening and assessment, as seen with the systematic review, although definitions were provided in the survey. Alternatively, it may be a true representation of current practice; surgeons feel responsible but consider it not part of their role. This was echoed in Paper 3 through four subthemes: collaboration: **P6 (TH)** 'I think you've got to trust others – their expertise.'; ownership: **P9 (TH)** 'It's my name above the bed'; and, culture: **P11 (DGH)** 'Surgeons want to 'surge'' and conflict: **P13 (DGH)** '...we're carrying the can for this decision and so if I think they need TPN, ultimately that should be the case...If it's all just opinion-based then my opinion wins.'

Nutrition support teams had relatively little involvement at this stage. This may be because NSTs have a greater role in managing malnourished patients rather than identifying them.

**Finding 3: Multiple healthcare professionals are involved in managing malnourished EGS patients.**

Little over half of surgeons (57.4%, 85/148) felt primarily responsible for managing malnutrition in EGS patients (Paper 4), although this time surgeons with IF experience were more likely to feel responsible (65.2% vs 50.6%, study 4). Where participants did not feel responsible, the NST was considered to fulfil the role by consultants and surgeons with IF experience.

Quantitatively, gastroenterologists were not considered responsible for identifying, or more surprisingly, managing malnourished EGS patients (Paper 4) despite being considered the 'gatekeepers' by consultants in the qualitative study (Paper 3). This is illustrated by **P9 (TH)** *'[Gastroenterologists] used to come along and say, 'This is the nutrition plan.' I'd say, 'I disagree with it so therefore you need to take the patient over.' They would say, 'Well we're not the named consultant therefore, there you go.' I'd go, 'Great. In which case I want TPN.'*

This unexpected finding may be explained by the fact that gastroenterologists are typically a member of the NST, and it is the NST that is primarily responsible for managing malnutrition in EGS, not a single named consultant gastroenterologist.

**Finding 4: There is a lack of organisational support for malnourished EGS patients.**

A recurring theme was a lack of organisational support to allow malnourished EGS patients to be identified and managed appropriately. Paper 2 showed agreement between surgeons and anaesthetists regarding this, with 16.3% (50/307) of participants overall reporting it. It was the third commonest local barrier identified in this study, after a lack of time in the emergency setting (23.1%, 71/305) and a lack of training and education (18.2%, 56/305). It was jointly equal with a lack of clarity about who is responsible for managing perioperative malnutrition.

The findings from Paper 4 mirrored the results from Paper 2. Overall, 18.2% (27/148) of participants disagreed or strongly disagreed that their organisation provided the support they needed to identify and manage all malnourished EGS patients. While trends were seen across surgeon seniority and experience of IF, they were greater in those more junior colleagues with no IF experience. Conversely, only half of participants (51.3%, 76/148) report having adequate support from their organisation.

Interviews with consultant EGS surgeons illustrated similar issues. Participants provided succinct summaries of the disparity between hospitals with organisational support (IF units) and those without (non-IF units):

**P14 (IFU)** *'I think we probably are [too liberal with nutritional support]. I'm sure there are patients where we use it for three, four or five days...in any other hospital, that's just you know, that's rocking horse poo.'*

**P16 (IFU)** *'The fact that I work in an IF unit...we'll deal with it.'*

**P18 (DGH)** *'You have to work with what you've got. You learn that very early on...there are lots of people that work in privileged institutions that have a privileged role...but if you're jobbing away as a jobbing general surgeon, you have to work with what you've got.'*

|                   |                                                                                         |
|-------------------|-----------------------------------------------------------------------------------------|
| <b>Finding 5:</b> | <b>Surgeons are not confident at identifying or managing malnourished EGS patients.</b> |
|-------------------|-----------------------------------------------------------------------------------------|

A lack of confidence in their team to identify and manage EGS patients with malnutrition was recognised by participants in Paper 2 when fewer than half reported as such (48.8%, 81/166).

A similar, quite subtle theme was recognised during the consultant interviews by one participant. They discussed feeling empowered to make suggestions about the nutritional management of a patient following a fellowship where nutrition was at the centre of patient care, yet before this experience they did not feel empowered:

***P9 (TH):** 'Empowerment...it was the empowerment of the surgeon to influence nutrition...how dare you, as a surgeon, even start talking to the nutrition team about nutrition. It was like, you know, I had absolutely no say in nutrition. And I'd just grown up with that, you know.'*

This lack of confidence was explored in Paper 4. Overall, only 37.2% (55/148) of all surgeons were confident they could identify malnutrition in EGS patients. Despite surgeons with IF experience being significantly more confident compared to surgeons with no IF experience (49.3% vs 26.6%,  $n = 148$ ,  $p = 0.008$ ), it is interesting that still more than half of these 'experts' lacked confidence.

**Objective 3:** To explore how consultants that undertake EGS identify malnutrition and the barriers they encounter.

**Finding 1:** The Surgeon: a lack of knowledge and understanding results from time-short, poorly trained surgeons and outdated surgical culture.

Qualitative methodology comprising semi-structured interviews highlighted nutrition in EGS is not taught well. There was insight that although surgeons appreciated the importance of nutrition in EGS, poor training with an absent nutrition component on the curriculum, as well as surgeon ignorance, leads to poor understanding (**P11 (IFU)** 'I know there's some stuff in ISCP [training portfolio] but it's pretty vague.').

The impact of malnutrition on patient outcomes and poor training was quantitatively corroborated in Paper 4. While 98% (145/148) of surgeons agreed malnutrition can affect patient outcomes, a majority of surgeons (81.7%, 121/148), across all grades and IF experience, responded that the training they received does not allow them to identify malnourished surgical patients. Overall, a lack of training was also the second commonest reason why screening was not performed all the time (21.3%, 19/89). Specifically for why screening was not performed every time, it is noteworthy that fewer consultants reported a lack of training as an issue compared to non-consultants (16.1% vs 24.1%). They also screened for malnutrition more than non-consultants ( $p = 0.035$ ). This difference may relate to variation in training among surgeons for specific elements of a nutrition practice in EGS, or consultants developing experience and screening patients by 'eyeballing' them, which was a routine method reported in the interviews (**P1 (TH)** 'It's mainly about eyeballing them'). This is contradicted by Paper 4 demonstrating that an 'end of bed clinical impression' was used by 84.5% of surgeons, with no significant difference according to seniority.

A lack of time pre-operatively to screen or implement nutritional support was reported in Paper 2. This was echoed in the interviews (**P1 (TH)** 'We don't have that luxury in emergency surgery'). Nutrition was also viewed as a 'soft' area of surgery (**P12 (TH)** '...malnutrition...is kind of 'non-surgical'). Surgical 'dogma' also means albumin continue to be used as a marker of nutritional status, as discussed later.

**Finding 2:**

**The Surgeon: surgeons routinely seek advice, but this is not always accepted and conflict ensues.**

While no studies in the systematic review relied on specialist involvement of other healthcare professionals to diagnose malnourished EGS patients, surgeons repeatedly expressed a reliance on them clinically: *'It's something that I very much need some guidance and some help with.'* **P10 (TH)**. One surgeon explained, *'If we ran this as a business, where you and I were setting up EmergencyGeneralSurgeryCare.com...you wouldn't leave it to a junior doctor or a routine nurse to assess whether they've got nutritional needs or not, would you? You'd employ someone to come round...and recommend nutritional plans for them accordingly'* **P18 (DGH)**. Surgeons also accepted an opposing opinion, *'They say, 'No [first name of surgeon], that's bollocks. You know, this is what I think we should do.' That's fine. We'll go along with that...I think it's part of teamworking, isn't it?'* **P6 (TH)**.

This was validated in Paper 4, where two-thirds of surgeons (68.2%, 101/148) agreed or strongly agreed with the statement *'I seek help or advice from colleagues when deciding a patient is malnourished'*. There was a trend for junior surgeons without IF experience agreeing with the statement, although there was no significant difference. This reliance on more expert help may also be in response to the vast majority of surgeons reporting they do not use evidenced-based practice when deciding a patient is malnourished as shown in Paper 4. However, these findings may also suggest being an IF consultant, or working in an IF unit, may be an important difference; this is considered in due course.

It is important to highlight that a small proportion (6.2%, 19/307) of surgeons reported a lack of a working relationship with the dietetic team as a local barrier to identifying malnourished EGS patients (Paper 2). The interviews illustrated issues around a *'permanent staffing crisis'* or *'absence of seven-day working'* and access to the nutritional service, as well as overall ownership of a patient's care; all of which were strong subthemes from interviews with consultants. However, conflict between healthcare professionals existed: **P9 (TH)**: *'So, so I'll tell you, we have had intestinal failure patients who I have totally disagreed with the plan and that's absolutely fine. I've moved the patient to [an IF unit].'*

**Finding 3:**

**The Patient: Malnutrition is identified using an assortment of methods, but screening with MUST is dubious.**

As evidenced in the systematic review, an assortment of similar methods are used by surgeons to identify malnourished EGS patients clinically. Weight loss, BMI, albumin and days without oral intake will be discussed due course.

Screening tools are recommended by guidelines(98,101,106,107). Despite the Malnutrition Universal Screening Tool (MUST) being used by 56.6% (94/166) of surgeons, a tool recommended in the UK by NICE, 40.1% (68/166) of participants did not know which tool was used at their own trust, as demonstrated in Paper 2. A total of eight tools were used to some extent. Paper 4 suggests MUST is used even less often, as only 40.5% (60/148) of surgeons in this study report using it, or the Wales equivalent WAASP, regularly or all the time. There is also a wide disparity in who uses it. Consultants and surgeons with IF experience use it significantly more than non-consultants and surgeons without IF experience (both  $n = 148$ ,  $p = <0.001$ ).

The interviews would suggest this is for a multitude of reasons. While one participant reports it is undertaken by nursing colleagues routinely, another participant states, *'I know it gets measured but I don't know what it is [laughing]. It's not something I look at. I know the dietitians measure it and as long as they're acting on it, that's what's important I think.'* **P2 (TH)**. Others explained it had limited use in EGS as it is either not validated or adds little value as *'[if made aware a patient has a high MUST score] I think I'd probably have worked that out for myself to be honest'* **P11 (IFU)**. Others expressed concern it doesn't change the clinical course of action because, *'In reality wise, it's good to know, but actually if they've got peritonitis, perforation, or some sepsis that needs controlling, you're heading down a particular path come hell or high water'* **P14 (IFU)**. Paper 2 quantitatively showed this feeling of pointless screening as 21.7% (51/235) cited screening having little effect on the immediate management of EGS patients as a key reason not to screen pre-operatively for malnutrition. Almost one third of surgeons (39.2%, 26/89) also reported this reason in Paper 4.



**Finding 4:**

**The Institution: being an IF surgeon or working in an IF unit is different to not being an IF surgeon or not working in an IF unit.**

IF units treat patients with intestinal failure and likely need nutritional support that other hospital settings are unable to. Working as an IF consultant, or working in an IF unit, appeared to confer a benefit to the surgeon and the patient.

Ten IF surgeons (6.8%, 10/148) completed study 4. Although a small number, there are insights to learn. Compared to non-IF surgeons, IF surgeons more strongly agreed across a range of questions including: understanding malnutrition significantly impacted surgical outcomes; recognising identifying malnourished patients is an important skill for surgeons; and reporting more frequently to screen for malnutrition. Surprisingly IF surgeons also reported a lack of training and confidence in identifying malnutrition, although they use evidence-based practice more frequently. The in-depth interviews with surgeons working at IF units revealed '*...there's no doubt that we do things here that we know we can because we do it in other patients.*' **P11 (IFU)**. Their elective practice shapes and informs their EGS practice.

Access to and provision of nutritional support was less of a concern in IF units compared to other hospital settings. IF surgeons appreciated they work in '*privileged positions*' with adequate funding so could provide prolonged nutritional support pre- or post-operatively and operate at the most appropriate time. Paper 4 demonstrated 80% of IF surgeons felt their organisation supported them, compared to half (34/65) of non-IF consultants. This was significant when comparing IF consultants to all other participants ( $n = 148$ ,  $p = 0.042$ ) but not to other EGS consultants alone ( $n = 65$ ,  $p = 0.598$ ). It also appeared to impact outcomes for patients: '*So we know that we've got ease of access to TPN etc so we would be less likely to do an anastomosis in the context where we would, sort of, be doing it on a hope and a prayer*' **P17 (IFU)**.

Interestingly however, these issues also appeared to exist within an IF unit. Describing a colleague without a primary IF subspeciality, one participant explained '*...he actually finds it much more difficult than I do to access services for these patients...he just doesn't have a day-to-day working relationship with them and sharing patients with them all the time*' **P14 (IFU)**.

**Finding 5:**

**The Wider Context: there is a need for a well-designed nutrition in EGS trial.**

The systematic review clearly showed a heterogeneous research landscape for nutrition in EGS. There was a wide variation in study design, population, definitions, and tools used to determine malnutrition in EGS. This makes any meaningful meta-analysis impossible.

Obtaining research ethics to perform a trial was also considered impossible, as one participant in Paper 3 stated, *'You'll never get ethics to starve half your EGS population and feed the other half'* **P14 (IFU)**. Designing studies was required though, *'There are some studies that I'm aware of that show the earlier intervention, from a nutrition point of view, with bowel obstruction, the better the outcomes. But again, it's not great data – it's not randomised control trial data. It's sort of audit type data'* **P10 (TH)**. However, whether this would change practice is unclear as *'...if a surgeon doesn't agree with it, they'll just pick holes in it and not believe in it...even with a well, you know, a well-studied randomised trial'* **P1 (TH)**. This may explain why only 41.2% (61/148) of surgeons in Paper 4 reported using evidenced-based practice when deciding a patient is malnourished.

Only 2% of participants believed there was a lack of evidence showing nutritional support improves outcomes in EGS (Paper 2), although the interviews revealed questions surgeons want answering. To answer these, data is required. A potential accessible source of routine data is by adapting the NELA database to include questions about a patient's nutritional status. There are approximately 20,000 laparotomies performed each year in the UK alone(16), and 71.1% (118/166) of participants of study 2 supported this idea.

In addition to better research, it is evident that additional funding and resource are required, as well as streamlines guidelines, to reduce the *'postcode lottery'* described in the interviews. Standardisation of identifying and managing perioperative malnutrition by means of a *'pathway'* may help and 83.7% (139/166) of participants in study 2 agree with this notion.

**Finding 6:**

**Malnourished patients are more likely to be given a stoma, but less likely to be started on nutritional support.**

The qualitative study comprising of interviews with surgeons (Paper 3) revealed malnutrition altered decision making around whether to perform an anastomosis and when to start to nutritional support.

Surgeons recognised being malnourished was not an absolute deciding factor not to do an anastomosis, but it may 'sway' them not to as '*malnutrition is just another tick in that box*' **P14 (IFU)**. Contextual issues such as a proximal anastomosis versus a high output stoma, as well as the previously described funding, available resource and access to nutritional support also influenced this decision.

It follows however that if patients are given a stoma instead of an anastomosis because they are considered to be malnourished, then nutritional support would be warranted. Paper 5 demonstrated the opposite. Patients who have a small bowel resection and stoma are less likely to receive nutritional support (OR 0.838, 95% CI 0.650-1.082;  $p = 0.174$ ) compared to those that have an anastomosis (OR 1.563, 95% CI 1.102-2.216;  $p = 0.013$ ).

This is complex with many possibilities to explain why this is the case. It may reflect a surgeon's preference to see how a patient progresses clinically once the diseased bowel is excised. Surgeons may consider patients with an anastomosis will take longer to establish oral intake, and so nutritional support is likely to be required, while in patients with a stoma this is not the case. Alternatively, surgeons may prefer to start nutritional support to 'protect' an anastomosis, especially with a proximal anastomosis. It could even reflect surgeons' inability to 'eyeball' malnourished patients or be seen as '*non-surgical*' as participants in study 3 highlighted. It may even be seen as a failure of surgery. The timing of when to start nutritional support, and knowing when to operate, was a strong subtheme in the interviews. This was compounded by the challenge of planning ahead and predicting a patient's clinical course – '*I don't think you can really predict it*' **P10 (TH)** – and where a nutritional strategy was made, it was, '*mostly made up off a fag packet*' **P6 (TH)**.

**Objective 4:** To establish how senior decision makers identify malnutrition in EGS, how they were trained and how it may be improved.

**Finding 1:** Multiple measures are used to identify malnourished patients in EGS in clinical practice.

A wide selection of measures were used to identify malnourished patients in EGS, many of which are found in EGS research (Paper 1) and clinical practice (Papers 2 and 3).

Of the seven measures selected in Paper 4 to investigate this more closely, three have already been discussed at length (MUST/ WAASP, BMI and end of bed clinical impression), and the remaining four will be discussed with respect to the extent they influence decision making in the next section. These are albumin, percentage weight loss over time and 'reduced oral intake until now' and 'reduced oral intake from now'.

However, it is notable to highlight the extent of which these measures are used. Overall, 95.3% (141/148), 89.2% (132/148) and 84.6% (125/148) of surgeons used 'reduced oral intake until now', 'reduced oral intake from now' and an end of the bed clinical impression, respectively. Only 43.9% (65/148) used weight loss as a marker, but screening with MUST/ WAASP was the least used method at 40.5% (60/148).

The significance of 'reduced oral intake until now' may stem from previous collaborative research(49,50), as reflected in Paper 3: *'So you know, the eating thing. That actually came from a conversation I had with [researcher's name] about the NASBO study'* **P2 (TH)**. This emphasises the importance of research and impact it can have to change clinical practice.

NICE guidelines clearly state nutritional support is recommended for malnourished patients or those at risk within five days of admission. However, surgeons reported a range of acceptable days without oral intake before they considered patients to be malnourished, or would start nutritional support. Wider dissemination of guidelines is required, *'chalked in a way'* surgeons can understand (Paper 3).

**Finding 2:**

**Surgeons want better nutrition training and national surgical societies can help facilitate it.**

Poor training has already been discussed as a source for the degree of variation in how malnourished patients are identified and managed. Most surgeons report little formal training at medical school (13.5%, 51/379) or by way of a training course (6.6%, 25/379). Paper 4 confirms most 'nutrition training' has origins in advice from or observation of a surgical colleague, learning from others or learning from previous patient cases (experience). Similar responses are seen across seniority and experience of intestinal failure. The same study revealed there is an appetite for specific local teaching (30.9%, 77/249) or a short 1-2 day nutrition course (31.7%, 79/249). Participants report receiving training through specialist training posts or fellowships in free text responses.

Paper 3 confirmed surgeons want to improve their training in nutrition in EGS. Suggestions included, *'...a little nutrition teaching package for surgeons'* **P3 (DGH)** and surgical representation on nutrition support teams, with it built in to job plans. It was suggested nutrition should be on the agenda for national surgical associations, not limiting it to dietetic societies, *'The message being brought from the dietetic world, from being something you've never heard about at BAPEN [British Association of Parenteral and Enteral Nutrition], to something you're hearing about at ASGBI [Association of Surgeons of Great Britain and Ireland] and ACP [The Association of Coloproctology of Great Britain and Ireland (ACPGBI)]. I think making people more aware of it I think is what is needed'* **P14 (IFU)**.

A wide-reaching Delphi study including participants from major surgical associations, the Scottish Surgical Research Group, the World Society of Emergency Surgery and the ASGBI has recently advised on 17 research priorities in EGS(360). Unfortunately only 3/267 questions in the first round related to nutrition in EGS, and none made the consensus list. Nutrition in EGS is currently a blind spot for clinicians and associations that represent them. As one participant stated, **P6 (TH)** *'I think if the impact of poor nutritional management was better known, if there is a significant one – I suspect there will be – and there's some data out there, then I think it would go up people's priorities and people will be more inclined to make time for it.'*

**Objective 5:** To determine the impact of key variables on senior decision makers' treatment preferences to start nutritional support for EGS patients.

**Finding 1:** Hypoalbuminaemia is misused as a marker for malnutrition and influences operative and clinical decision making.

Throughout all five studies, albumin was a distinguishing feature. It was:

- a) The second most used malnutrition marker in a systematic review (Paper 1)
- b) The most used maker of malnutrition in a survey of NELA Leads (Paper 2)
- c) Considered '*objective*' and a '*language*' between surgeons that it is diagnostic of malnutrition in interviews (Paper 3)
- d) Used as a marker of malnutrition to drive decision making around forming an anastomosis, '*Somebody who is malnourished with albumin in their boots, I'm less likely to do certain anastomoses*' **P7 (TH)** (Paper 3)
- e) Used significantly less by IF consultants when compared to non-IF consultants (n = 75, p = 0.019) or all other participants (n = 148, p = 0.024) (Paper 4)
- f) A significant independent driver to start nutritional support at all levels of hypoalbuminaemia (all p = <0.001) (Paper 5)

This MMR has shown that hypoalbuminaemia plays a more substantial role for many surgeons in identifying and managing malnutrition than it should. While many recognise that it does not have a role in the emergency setting, a large proportion of research and clinical decision making still uses this biomarker. It is most probably based on historic evidence which linked hypoalbuminaemia, malnutrition and poor surgical outcomes including mortality, and called for an increase use of albumin as a 'prognostic tool and for detecting malnutrition'(94).

|                   |                                                                                                 |
|-------------------|-------------------------------------------------------------------------------------------------|
| <b>Finding 2:</b> | <b>Malnourished patients may not be receiving the appropriate management if they are obese.</b> |
|-------------------|-------------------------------------------------------------------------------------------------|

Again, BMI has been another major distinguishing feature of all five studies of this MMR. Its use has been discussed previously (Papers 1-4). However, Paper 5 also quantitatively demonstrated that it influences decision making regarding starting nutritional support, which was suggested by the findings of the qualitative study (Paper 3).

Paper 3 demonstrated that while some surgeons recognised that malnutrition can be missed in obese patients as they can lose weight without *'looking thin'* – remember, experienced surgeons are able to *'eyeball'* malnourished patients – many interviewees were very unambiguous; obese patients cannot be malnourished:

**P5 (TH):** *'So, the idea of the very, very overweight, but also malnourished patients, which I know is an absolute fundamental of dietitian practice and all the rest of it, I would say I'm not a massive believer in, which, you know, might be just my ignorance...Because they're clearly not, you know, they're not unwell in any way from their...from their lack of...their lack of proper nutrition!'*

**P14 (IFU):** *'But I think from a nutrition point of view, rightly or wrongly, we don't worry about the fat ones so much...probably because we don't understand it isn't it? We can see unhealth and think it's skinny people and frailty...there's a philosophical thing around culture and increasingly high BMI being the normal.'*

Paper 5 confirmed this sentiment in a rather alarming step-wise fashion. Using normal BMI as a reference category, surgeons were more than twice as likely to start nutritional support in underweight patients (OR 2.232, CI 1.715-2.906,  $p < 0.001$ ) but were less likely to do so in overweight patients (OR 0.893, CI 0.740-1.077,  $p = 0.234$ ) and almost half as likely in obese patients (OR 0.751, CI 0.584-0.965,  $p = 0.025$ ). Obese, malnourished patients may be being missed. This is concerning in a society where the population has an obesity crisis(108).

**Finding 3:**

**Weight loss is a marker of malnutrition for senior surgeons and those with experience of IF.**

Paper 5 demonstrated that nutritional support was more likely to be initiated in patients with a substantial degree (>10%) of weight loss (OR 1.651, CI 1.159-2.351,  $p = 0.006$ ) compared to those that have lost a smaller amount (0-4.9%).

However, whilst it is a key criteria to diagnose malnutrition in UK guidelines(98), and similar ranges are provided in other guidelines(43,101,107), only 43.9% (65/148) of surgeons use percentage weight loss to determine nutritional status according to study 4. Additionally, the degree to which it influences the decision to start nutritional support is less than that for any degree of hypoalbuminaemia.

This could be because of the historic influence of albumin, the difficulties of weighing patients when they are critically unwell, or that weight loss is considered a 'soft maker' of nutritional status, or a combination of these. This concept was reiterated by Paper 3, *'For me personally, and my colleagues that also work in the IFU, I think we see it, we see it very differently. We're more attuned to malnutrition than most. Things that interest us, there's a magical number of 10%. If you've lost 10% of your body weight in the preceding [three months], we'll start to get a bit twitchy about that as that's a proper sign you're losing ground.'* **P14 (IFU).**

Paper 4 confirmed a statistical difference in the use of weight loss according to seniority and experience of IF. Consultants and those with IF experience were more likely to use weight loss as a marker of malnutrition than junior surgeons ( $n = 148$ ,  $p = 0.001$ ) or those without experience of IF ( $n = 148$ ,  $p = 0.002$ ), respectively.



**Finding 4:**

**Oral intake influences the decision to start nutritional support more than any other variable.**

Oral intake was a common strand running throughout many aspects of this MMR.

It was used as a key measure in 8/15 nutrition screening and assessment tools in the systematic review. Paper 5 also demonstrated starting nutritional support was significantly associated with a progressively increasing number of 'days without oral intake until now' and 'days likely to be without oral intake from now' (all  $p = <0.001$ ). Of all the variables studied in the DCE, these were the most influential drivers of starting nutritional support. This is corroborated by Paper 4 whereby 'reduced oral intake until now' and 'reduced oral intake from now' were used by 95.3% (141/148) and 89.2% (132/148) of surgeons respectively; again, the most of all the variables investigated. This suggests what surgeons do correlates with what they say they would do. It also suggests the entire patient journey and their oral intake was considered important. This was often phrased as 'pre-op' or 'post-op' in the interviews, which reiterates the findings from the above studies, *'Like I say, for the emergency ones if we think that probably it's been a week, which is probably about a number to pick for, once we're looking at a week out, we would be starting some TPN and we're aware that that's the pre-op stuff as well'* **P14 (IFU)**.

It is worth drawing attention to guidelines. While patients who have 'eaten, or are likely to eat, little or nothing for five days' is a criteria for NICE guidelines, others reflect days without oral intake through the guises of daily 'energy requirements' (98,101,107). Although the underlying sentiment is the same, this terminology is off-putting for surgeons and not useful in clinical practice, *'But just because I don't know how to do it properly, and I definitely don't have time or willingness even to try to understand or remember those formulas to calculate calorie nutritional support that they need. So, I usually give it to somebody who knows what they doing'* **P7 (TH)**.

**Objective 6:** To understand if surgeon seniority or experience of intestinal failure influences surgeon decision making regarding starting nutritional support.

**Finding 1:** The decision to start nutritional support in EGS does not appear to be influenced by surgeon seniority.

The same participants completed study 4 and study 5. There was an even distribution of consultants and non-consultants in these studies. Several similarities and differences have already been highlighted throughout this summary of findings with respect to how surgeons identify malnourished EGS patients. Two additional salient points are presented below.

Firstly, Paper 4 established all consultants (75/75) and 95.9% (70/73) of non-consultants considered identifying malnourished patients an important skill for surgeons. Secondly, Paper 5 demonstrated no significant difference between consultants and non-consultants in whether they started nutritional support (OR 1.406, CI 0.936-2.114,  $p = 0.100$ ).

This contrasts with Paper 3 which suggested there may be a difference because, *'Most of what we do is probably based on kind of instinct and experience rather than methodology and science'* **P4 (TH)**. Other consultants reported, *'not leaving it [determining nutritional status] to a junior doctor'*, and it not being part of a junior doctor's *'job to do'*. These suggested learning to identify malnourished patients is something that takes time to develop, and is a task consultants can do and more junior surgeons cannot do. The differences between study 3 and study 5 may be due to the study design of study 5 which categorised all non-consultants including trainees and non-trainees together.

**Finding 2:**      **The decision to start nutritional support in EGS does not appear to be influenced by experience of IF.**

Participants that completed study 4 and study 5 also provided information on their experience of intestinal failure. Again, there was an approximately equal split between surgeons with experience of IF and those without, and many of the similarities and differences have been highlighted already.

Paper 3 demonstrated perceived differences in terms of access to nutritional support between surgeons at the same hospital depending on their day-to-day interaction with the IF team, as well as institutional differences between surgeons at IF units versus non-IF units. This seemed to influence surgeon behaviour, with IF surgeons considering themselves *'too liberal'* with starting nutritional support at times *'because they can'*. Surgeons stated it had *'influenced my working'*. Therefore it was expected that IF experience would influence the decision to start nutritional support.

However, this sentiment was not entirely borne out in the data in Paper 5. Surgeons who worked in an IFU or had IF experience were more likely to start nutritional support than surgeons who did not work in an IFU or did not have IF experience. However, there was no significant difference between surgeons with experience of IF and those without in whether they started nutritional support (OR 1.093, CI 0.732-1.631,  $p = 0.663$ ). Odds ratios were not calculated for IFU surgeons.

The design of the study may have influenced findings. Firstly, IF experience was self-reported. Surgeons with minimal IF experience may have considered themselves to have sufficient experience for this study. Secondly, in the DCE institutional differences were not captured as it was not selected as a variable of interest. A surgeon may change their decision making depending on their working environment. The interviews captured this, *'...if you're jobbing away as a jobbing general surgeon, you have to work with what you've got'* **P18 (DGH)**. Finally, the DCE does not capture information on the timing of when nutritional support would be started, which was a key theme in Paper 3. IF surgeons may opt to start nutritional support sooner than their non-IF colleagues.

## Chapter summary

- A mixed methods approach has enabled both thesis' research questions to be addressed.
- Findings of all five studies were systematically discussed in relation to one another to triangulate the relevant findings and enable a broader understanding of how and why surgeons identify malnutrition in EGS.
- In total, there are 21 summary findings for the six thesis objectives.

## 7 Discussion

This chapter explains the novelty of the thesis findings and offers suggestions as to what the impact of these findings will be for surgeons, policy makers and researchers. Six future research projects are proposed under four headline areas. The strengths and limitations of this thesis are highlighted, as are the researcher's reflections on the research process itself.

### 7.1 Novelty and findings in context

EGS is a busy subspecialty(2,3,5). Patients are often complex and diverse, and although outcomes have improved, nearly 1 in 10 patients do not survive 30 days post-operatively(16). This has plateaued in recent years following systemic changes in relation to access to imaging, timely theatre provision, consultant-led input and appropriate post-operative care(13,16,361). Other modifiable perioperative risk factors may have a role, such as malnutrition. Indeed, EGS patients are often malnourished(8,48) and malnutrition is independently associated with poor surgical outcomes(7). It also has an associated financial burden for the healthcare system(53). However, we do not routinely collect data regarding malnutrition risk in the EGS setting, and this may represent a blind spot in providing optimal care for these high-risk patients.

Targeted nutritional support for these patients may help by mitigating some of the surgical stress response(28,33). Providing the best surgical care to this group by optimising nutrition in the perioperative phase relies on adequately identifying them; Papers 2, 3 and 4 show surgeons are not confident we do this effectively. Further, there is inconsistency in the definition of malnutrition in EGS within guidelines, which do not specifically target this vulnerable population. Research with an EGS population is subject to several challenges, not limited to the time-critical nature of an emergency admission and the complexity of patients and pathways. This is demonstrated through the heterogeneity evident in trials examining nutritional therapies in EGS in both EN(123–137) and PN(124,129,144–149), with major differences in study population, design, definition, use of nutrition tools, initiation of nutritional support and outcomes reported. Paper 1 also showed malnutrition is defined by a variety of methods in research, and it may be that this influences clinical practice.

To this end, this thesis aimed to understand what similarities/ difference exist in how surgeons identify malnutrition in emergency general surgery, and if there are differences, then why they exist. It encompassed five stand-alone but interlinked studies using a mixed methods approach. This approach

has enabled an aerial view of the issue with triangulation of findings which otherwise would not have been possible. In doing so, it has:

- provided a more distinguished insight into how surgeons identify malnourished EGS patients and define malnutrition, with opportunities to educate and change practice
- clarified which nutrition tools and markers have been used in research, and which are used clinically by surgeons
- exposed how clinicians determine the nutrition status of a patient and provided an understanding of why this is, the barriers encountered and how to overcome them
- demonstrated these barriers can impact clinical and operative decision making
- highlighted the role of several variables used by surgeons to determine when to start nutritional support
- demonstrated the influence of hospital setting, surgeon seniority and experience of IF in a range of domains around identifying malnourished EGS patients and the initiation of nutritional support using multiple research methods.

## 7.2 Impact of findings for surgeons

This MMR would not have been possible without surgeons participating. It is easy to cite additional time, funding, staffing, access to nutritional support, infrastructure and resource as the only necessary changes required to improve how surgeons identify and manage malnourished patients in EGS. However these do not recognise an underlying theme captured in the interviews with consultants.

### **Change starts from within**

Traditions and 'dogma' were recurrent topics during this study. Most noticeably these related to the persistent use of hypoalbuminaemia as a measure of malnutrition, and a misunderstanding that patients with obesity could not be malnourished. It is surprising these factors significantly influenced the decision to start nutritional support, although weight stigma is prevalent and has been shown to impact the provision of healthcare(362,363). Despite almost all surgeons recognising malnourished patients can have worse outcomes than non-malnourished patients, and that being able to identify the difference is an important skill for us to have, others considered it 'non-surgical'. Some surgeons placed faith in other healthcare professionals with the appropriate expertise, or sought input from them, but others reported a belief that surgeons know best; one surgeon even transferred a patient to a different hospital following disagreements with colleagues about a patient's nutritional plan. This extends to surgeons reporting not believing in good quality research. There is institutional learning of behaviours such that surgeons mirror one another because surgeons are internally appointed.

Surgeons must continue to challenge their own beliefs and those of others to ensure the appropriate identification and management of malnourished patients. Further education is mandatory, but other approaches can also benefit surgeons. These include: developing a better relationship with the NST or becoming embedded within it, perhaps through amended job plans; attendance at relevant conferences; a review of latest guidelines; and, undertaking quality improvement programs, audit and research. Surgeons must aim to minimise the effect of a resource-stricken health service to ensure patients that would benefit from nutritional support rightly receive it.

## 7.3 Impact of findings for policy makers

This mixed methods study has shown wide variation of current practice with screening and assessment of malnutrition among NELA-eligible patients. Surgeons have low confidence in their abilities, and organisational barriers exacerbate the problem. These cannot be explained by laparotomy volume or professional role. Decision making to start nutritional support is also not related to surgeon seniority or experience of IF. However, surgeon- and organisational-level challenges prevail and may account for the adverse outcomes this vulnerable patient group experience. There are three areas policy makers should consider addressing.

### **Surgeons need training**

This study highlighted knowledge gaps in the methods used for the routine identification of malnutrition in EGS, often not in keeping with available guidelines. This is the case for research in EGS, and for surgeons that practice EGS. Many clinicians did not know which screening tool was used in their hospital, and many also continue to use albumin as a marker of malnutrition. It continues to influence decision making regarding which patients receive nutritional support. Translating evidence-based medicine and guidelines into clinical practice is difficult. It has previously been shown that surgeons value their own judgement above any other resource(364), however there is a desire for guidelines to be '*chalked*' in a way they can understand. A lack of training and education was considered a major barrier in three of the five strands of this MMR.

Treating malnutrition depends on identifying it through screening and assessment, and so redressing these gaps and improving surgeon knowledge of the issue is needed. Policy makers should consider how best to bridge these knowledge gaps and improve the dissemination and implementation of current guidelines. Our studies indicate a strong positive response for educational materials including a short course for surgeons and additional detail in the surgical curriculum. It should be aimed at promoting early recognition and referral of EGS patients that may become malnourished for a full nutritional assessment and consideration of nutritional support. There was also support for the development of a standardised protocol or pathway, although research of these in EGS is limited. Policy makers should consider more fully the benefit of these, and how these could be implemented.

### **Improve organisational support**

Findings from this thesis indicate an appetite for nutritional support which is not echoed clinically in national cohort studies(50). It has also shown the institution within which a surgeon works can impact



the identification and management of malnourished patients. Nutrition in EGS is evidentially a 'wicked problem'. Finite NHS resources negatively impact access to and provision of nutritional support for patients. There is a sense of a '*postcode lottery*' by surgeons, and this will be felt by patients. Working in challenging conditions may lead to issues around ownership of malnourished patients and likely reflects the conflict in decision making reported.

Policy makers should work with funding bodies to commission work to address knowledge gaps around the timing and delivery of nutritional support, and the short and long-term impact of nutritional support on outcomes from patient and organisational perspectives. Consideration should be given to the role of dietitians in the acute surgical setting to support best practice, and there need to be clarity of the roles and responsibilities of healthcare professionals in the context of nutrition in EGS more widely. Improved access to nutritional support is needed to meet demand.

## **Recognise its importance**

Since its inception, NELA outcomes have improved and these are likely related to systemic changes including earlier input of senior clinicians, access to appropriate imaging and antibiotics, as well as improved access to theatre and post-operative critical care(16). However, mortality has levelled-off in the most recent reports; other key factors may be limiting further gains such as patient risk factors and patient selection. The impact of frailty has become a recognised determinant of post-laparotomy outcomes and is associated with a two-fold increase in mortality following EL(16,365). It has subsequently been included as part of the NELA data collection process. More recently, NELA have been commissioned to audit patients requiring surgery but are not taken to theatre(366). This demonstrates that decision making for this vulnerable patient group is considered a valuable area to investigate and audit.

However, despite a well-established association with worse outcomes, malnutrition risk in EGS is not recorded on NELA and represents a relative blind spot in current care and audit. Policy makers might consider inclusion of nutritional status in routine datasets such as NELA, for which our study showed had wide support. This would allow correlations with outcomes at a population level. It must be acknowledged that the benefits of this will only be rewarded if met with funding and organisational improvements simultaneously. Despite a reduction in mortality with postoperative geriatrician review, their involvement continues to be the most poorly delivered standard for NELA patients regardless of an annual report highlighting this issue(16). Incorporation of these elements into Best Practice Tariffs will help, and was recognised as a solution by surgeons in our qualitative study.

## 7.4 Impact of findings for researchers

This MMR has demonstrated several aspects of identifying malnutrition in EGS requires further investigation (**Figure 7.1**). Four headline areas capture these next steps, and could be used to inform the development of a trial: further mapping of nutrition in EGS; understanding the needs of patients; application of GLIM guidelines to EGS; and an appraisal of the evidence.

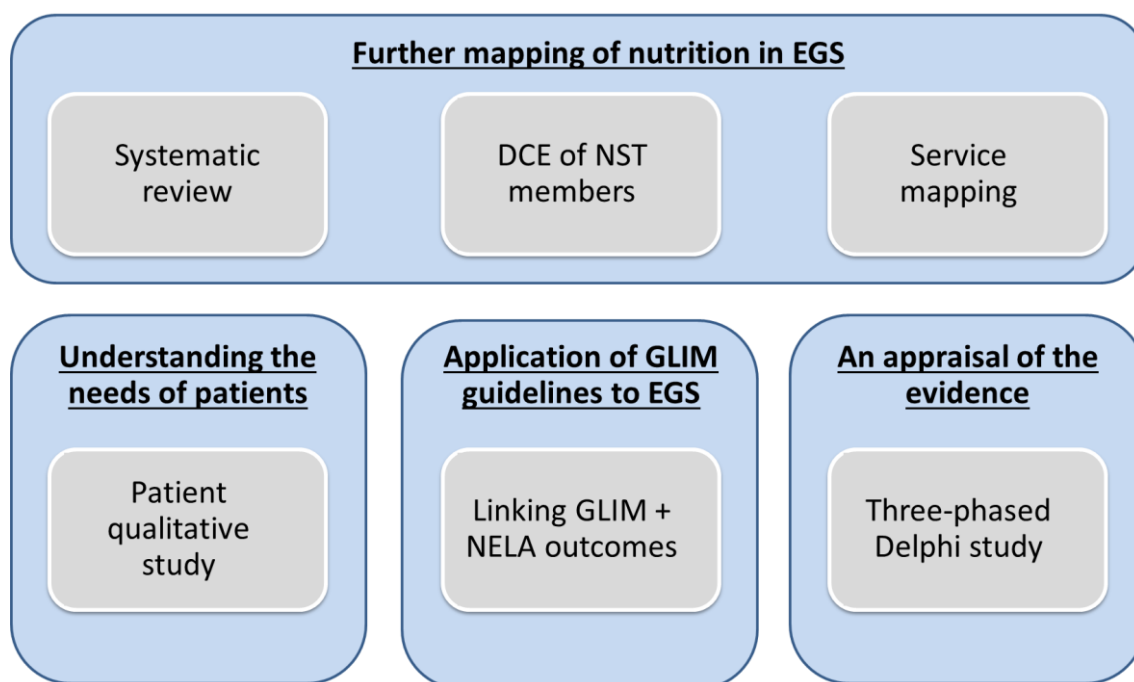


**Figure 7.1:** Proposed future research studies

## Further mapping of nutrition in EGS

It would be useful to formalise the literature review performed in chapter 1 which considered enteral and parenteral nutrition in operatively managed EGS patients. This would also build on study 1, which was a systematic review examining how malnutrition was defined in observational studies. A proposed PICO for a systematic review and meta-analysis of trial data comparing EGS patients that have received TPN and those that have not is shown (**Figure 7.2**). This uses a recently published core outcome set for nutritional interventions(160).

|                |                                                                                                                                                                                                            |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Population:    | randomised controlled trials of adult patients ( $\geq 18$ years) with an acute (unscheduled) admission to hospital under the general surgeons; operatively managed; any gender; not restricted to the UK. |
| Interventions: | received total parenteral nutrition                                                                                                                                                                        |
| Comparator:    | did not receive total parenteral nutrition                                                                                                                                                                 |
| Outcomes:      | odds of mortality in patients who received nutritional support vs those who did not adherence to core outcome set for nutritional interventions(160)                                                       |

**Figure 7.2:** PICO for possible systematic review of TPN trial data

Secondly, the DCE (study 5) highlighted several variables that influenced decision-making to start nutritional support by surgeons. However, study 3 (interviews) highlighted that in many settings surgeons identify potentially malnourished patients and refer on to a NST who decide if nutritional support should be initiated. A DCE to understand decision-making in members of the NST would confirm the relevance and degree of influence of factors such as BMI and days without oral intake (**Figure 7.3**). This may inform development of referral pathways.

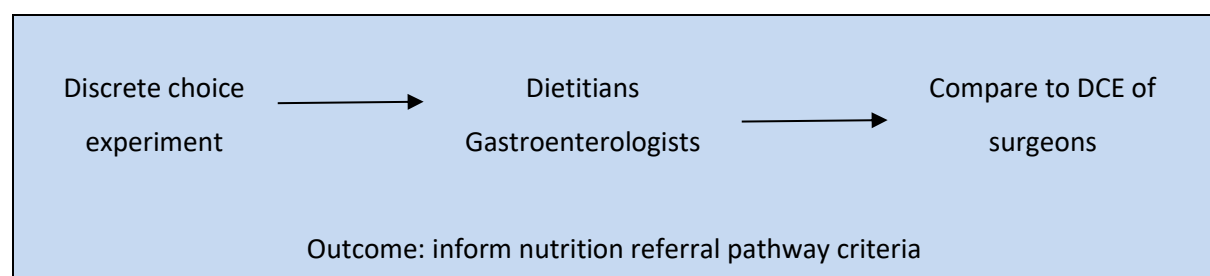


**Figure 7.3:** DCE of nutrition support team members study

Thirdly, as outlined in chapter 1, EGS is a diverse and busy subspecialty. While patients with small bowel obstruction or NELA-eligible patients are conceivably higher risk for requiring nutritional support at some point during their admission than patients with other EGS diagnoses, there are other

high risk diagnoses(7,9–11) which may be missed. Additionally, offering a nutritional assessment, and support where needed may not be possible due to a lack of funding, access and organisational barriers. Despite annual recommendations for greater elderly care input for the last eight years, it remains that fewer than a third of NELA patients aged 80 or over, or aged 65 and frail, had elderly care input(16). As such, identifying who would benefit most from targeted nutritional care and understanding future likely requirement for nutritional support in a resource-limited health context will guide nutrition referral and delivery pathways. This will assist developing an effective EGS service (**Figure 7.4**). This 'service mapping' study would be able to inform policy makers that for every  $x$  number of patients with  $y$  diagnosis, there are  $z$  percent of patients that required nutritional support.

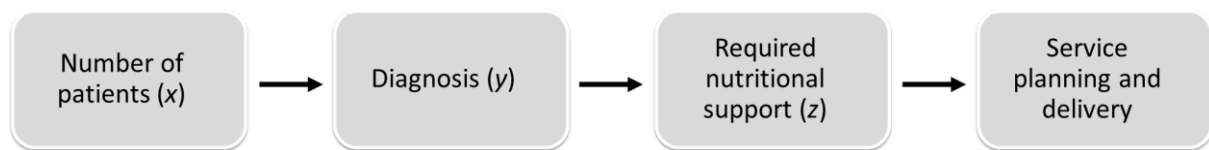


**Figure 7.4:** Service mapping study

## Understanding the needs of patients

The studies contained within this MMR have all been centred on surgeons; what they think, feel and do. We demonstrated variation in identifying malnutrition and the degree to which BMI influences decision making for nutritional support. We also highlighted the impact this can have for patients including a greater likelihood for a stoma. Therefore, understanding what this means from a patient perspective, including their involvement with decision-making around nutritional support given the risks involved, should be considered. A qualitative study with post-laparotomy patients receiving nutritional support could facilitate this (**Figure 7.5**).

|                                                                |                                               |              |
|----------------------------------------------------------------|-----------------------------------------------|--------------|
| 1. How do patients feel about their nutritional journey?       | Post-laparotomy patients with a BMI $\geq 30$ | Interviews   |
| 2. To what extent were they involved in decision making?       | Post-laparotomy patients with a BMI $< 18.5$  |              |
| 3. What information were they given pre- and post-operatively? | Post-laparotomy patients with a stoma         | Focus groups |
| 4. How can we improve nutritional support?                     | Post-laparotomy patients without a stoma      |              |

**Figure 7.5:** A possible qualitative study involving patients

## Application of GLIM guidelines to EGS

The most recent consensus and widely accepted international guidelines on identifying malnutrition are the Global Leadership Initiative in Malnutrition (GLIM) guidelines(101). Risk screening is performed using a validated screening tool such as MUST, followed by a second step for assessment to diagnose and assess severity of malnutrition. A modified criteria (mGLIM) has been applied to American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) data, the equivalent of NELA, although muscle mass and food intake were not included(262). GLIM criteria have been shown to be predictive of adverse postoperative outcomes and mortality following EGS(367). However, GLIM criteria have not been applied to the EGS or NELA cohort in the UK. Any request for such data would require a data access request to NELA, however the data is not currently licensed for research purposes. This could be performed as a multicentre cohort study or incorporated with NELA data, especially given the almost all patients have a CT scan and sarcopenia can be measured (**Figure 7.6**). Analysis of NELA outcomes which incorporates a diagnosis of malnutrition based on GLIM data may inform future patient risk stratification, nutrition pathways, future trials and policy recommendations.

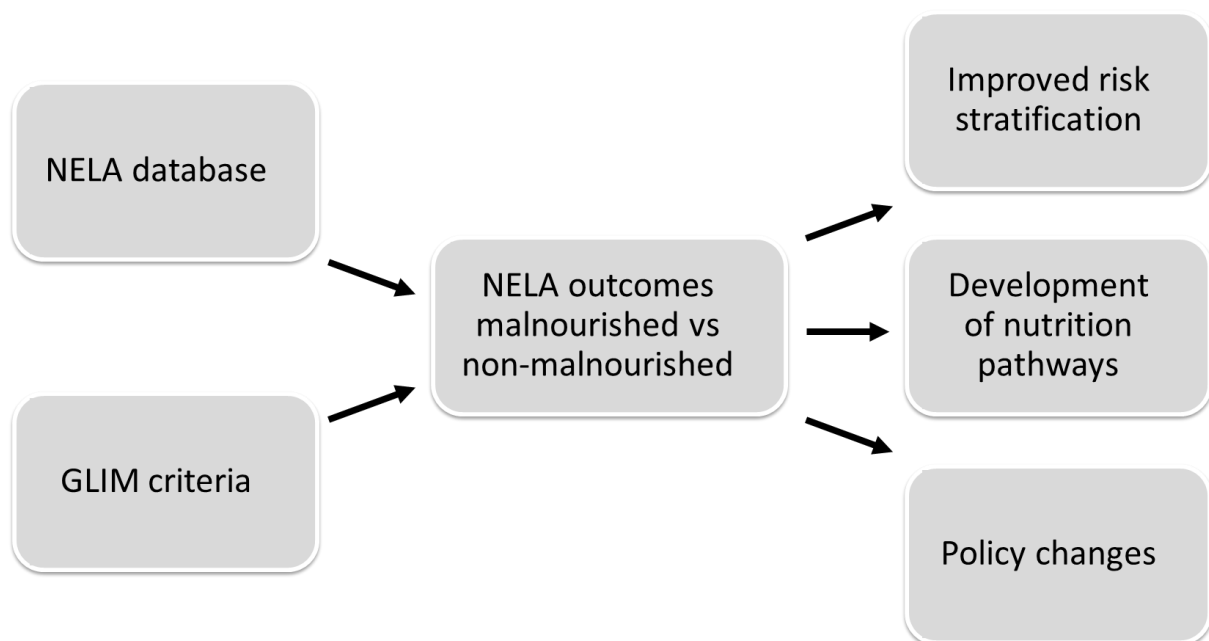


**Figure 7.6:** A cohort study investigating GLIM criteria on NELA outcomes

## An appraisal of the evidence

The above suggestions for future research proposals will continue to highlight the fundamental need for nutrition in EGS to move to the forefront of the minds of surgeons, and to reduce the variation in how malnutrition is identified and managed. However, this MMR demonstrated surgeons do not consider there to be a lack of evidence that malnutrition results in adverse outcomes. Additionally, nutrition in EGS was not considered a key research priority in a recent consensus exercise(360). But issues such as poor training, poor compliance to guidelines, inherent biases influencing decision making and a host of barriers facing surgeons highlight a need to pause and reflect as a community, and assess what the next steps should be. A Delphi study could be undertaken to appraise current research and establish a research and policy agenda with respect to improving nutritional care for malnourished patients in EGS (**Figure 7.7**).

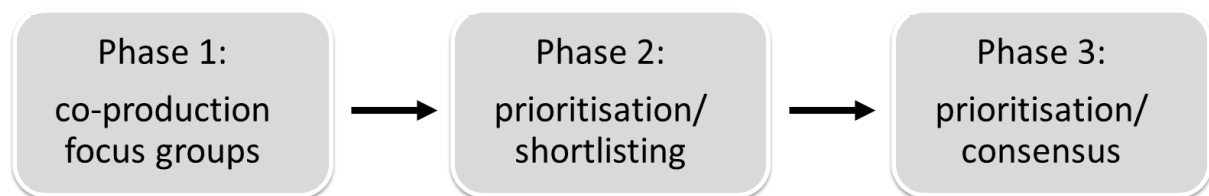


**Figure 7.7:** A three-phased modified Delphi with two prioritisation phases

## 7.5 Strengths of the study

The strengths of each strand of this MMR were highlighted in the relevant chapters. The design of this MMR is its major asset. The advantages of mixed methods were discussed in chapter 2. How each benefit of conducting MMR, as outlined in **Table 3.3**, is discussed below in relation to this study.

### Triangulation

The results of each strand of this study have been distilled to corroborate major findings using different methodologies. An example of this is the use of BMI and hypoalbuminaemia as a marker of malnutrition in all five studies. Findings have shown to what extent they are used in research, by clinicians, how they inform decision making, and why this remains the case.

### Initiation

There have been differences demonstrated between the studies which would not have been known or understood without an MMR approach. Study 3 gave a sense that surgeon seniority and experience of intestinal failure were major factors in identifying malnourished patients and initiating treatment. However, study 5 demonstrated no significant role for these.

### Complementarity

There have been many instances whereby the findings of one study have been enhanced or clarified by another. Study 3 provided much of this rich data which would not have been obtained through quantitative methods.

### Development

As depicted in **Figure 3.4**, the findings of one strand of this MMR has informed the design of future strands. Studies 1 and 2 highlighted what variation exists in how malnourished patients are identified, and study 3 aimed to account for why this is the case. Itself then directly informed the development of study 4 and study 5.

### Expansion

Using multiple, varied approaches as part of this MMR has allowed a greater breadth and range of investigation into how malnutrition is identified. This is demonstrated by: study 2 identifying a lack of training and confidence in this process; study 3 confirming the same but also highlighting the surgical curriculum is lacking; and study 4 indicating that surgeons want a short course in nutrition in EGS.



## **Completeness**

A more rounded investigation of the problem has been conducted by using MMR. Study 2 indicated there were several barriers to identifying malnutrition in EGS, and this were echoed in and explained by study 3.

## **Offsetting**

The limitations of a single study have been neutralised by other studies in the MMR. The study design, using both quantitative and qualitative studies, has achieved this to great effect. Additionally, this can be seen using two quantitative methods. Study 4 asked surgeons which variables they use to identify malnutrition but the study is limited by the nature of survey methodology. However, study 5 circumnavigated this and used a different methodology to determine the same findings without surgeons expressly stating so.

## 7.6 Limitations of the study

The limitations of each strand of this MMR were highlighted in the relevant chapters. While the design of MMR has been its major strength, there are limitations related to conducting research using this approach. These relate to selection bias, the complexity of EGS research and an absence of patient and public involvement in the design and implementation of this research.

### Selection bias

Studies using survey methodology may be affected by recruitment of participants with an interest in the topic being investigated, particularly where there is no financial interest attached. These studies can be time-consuming and rely on the goodwill of those taking part. This can affect response and completion rates, as well as undermine the findings of the study. In addition to addressing potential sources of error using the TSE framework, several other methods were employed to avoid these pitfalls. This included:

- Anonymity
- Appropriate study design: appropriate operationalisation, formatting and suitable testing with validated tools where possible
- Recognition of study quality with 'research support' by professional associations
- Broad advertising and recruitment through recognised professional associations and targeted social media groups (NELA group for example)

Study 2 specifically targeted NELA Leads at each hospital that submitted data to the NELA database. It had a participant completion rate of 57.4% and a hospital completion rate of 70.1%. Such high completion rates may be related to NELA Leads considering taking part in the study a necessary part of their role, however the nature of the study was made explicitly clear. Studies 4 (trainee survey) and 5 (DCE) used survey methodology but were distributed simultaneously. The reasons for this have been documented previously. Study 4 and 5 had a completion rate of 52.1%. These are far higher than studies of a similar nature<sup>(191)</sup>. Study participant characteristics in these studies also reflected the broad church of the wider surgical population, and together, these are reassuring selection bias was not a major flaw undermining the findings of these studies.

Study 3 was a qualitative study and used a purposive sampling method to ensure recruitment for surgeons according to surgeons sex, years qualified, and hospital setting. The participant burden is greater than with a 5-10 minute survey, as the interviews could last up to an hour. Whilst selection

bias cannot be eliminated entirely, it is evident in the richness of the data that the trustworthiness of the study is retained.

## **Complexity of EGS research**

As detailed previously, EGS research is fraught with the challenge that patient journeys are complex, the surgical management diverse and not 'one size fits all', and the systemic issues such as inadequate staffing and funding are beyond the control of the participants in this MMR. These issues will affect how malnutrition is identified and the findings of this study. This was recognised by surgeons during the interviews where institutional differences were discussed. These are 'wicked problems' and much of research in healthcare will be affected by its very nature. It may account for some of the variation in practice reported in these studies, as well as the absence of robust trial data as outlined in chapter 1. Study 5 used six variables to generate hypothetical scenarios and asked surgeons to decide whether they would start nutritional support; clearly this does not capture the intricacies of decision making.

However, the MMR approach to answer the research questions recognised this. Importantly, the degree of corroboration between each of the strands of the MMR demonstrates the overall findings of this thesis are reliable and relevant to the UK healthcare system as a whole.

## **Absence of patient input**

It is without doubt that patients offer unique insights into all stages of research and this MMR would have benefited from input of patients in the design of each of the strands of the study. While evidence suggests patients misunderstand what being malnourished means<sup>(368)</sup>, their interpretation of findings around decision making and the impact this has for patients would have been useful and added a new dimension to what the impact is for surgeons, policy makers and future research. Creating a patient 'emergency laparotomy network' would be invaluable to inform future research and trial design.

## 7.7 Researcher reflections

Undertaking this PhD has been one of the greatest accomplishments of my career to date. The challenges in preparing to do so, such as deciding on what topic to research, choosing a supervisory team, arranging funding and organising time out of programme pale into insignificance compared to the process of research itself.

Confidently entering the start of research with a proposal developed over the previous two years, I was quickly grounded with the huge difficulties that would have been encountered. I thank my supervisory team for pointing these out early on. Planning to recruit patients as part of a multi-centre observational study were halted by a realisation that I could not define which EGS patients were malnourished. I am still not sure I can. As with the nature of research, there are more questions that need exploring first and I feel excited to continue doing so in the future.

Although I had undertaken research previously, I have continued to learn so much during this PhD. I have a new appreciation for qualitative research. Firstly, it is much more difficult to do well than I thought initially, and during the interviews I found I was thinking about every single word of every question, my tone, intonation and mutterings of agreement. I was careful to avoid influencing participants' responses although I realise it is the nature of qualitative research that this will happen, and possibly more so given my clinical background and preconceived beliefs. Secondly, the data generated was voluminous! Despite that, it was the most enjoyable study to do, and the responses were so insightful; I am incredibly grateful for the time consultant surgeons gave me to be interviewed.

I have used this period of research to share findings by attending as many relevant meetings as possible. I am grateful for the opportunities to present at them, and the publications and prizes as a result. Many people have asked how I identify malnourished EGS patients, or how we should be doing it. I usually give a balanced answer including the pros and cons of current methods, and that further research is needed to find the perfect tool which is simple, quick, highly sensitive and highly specific. While such a tool may not exist, this research has pointed me to favour focussing on the number of days without oral intake, percentage of unintentional weight loss, and measuring psoas density as a representation of the degree of sarcopenia on the inevitable CT the patient has prior to their emergency surgery. Sharing my research has also helped to reassure me that my work is worthy and valid, especially for an area of surgery seen as 'non-surgical' and 'soft'. Beating the drum about the importance for surgeons to identify malnourished EGS patients (and not use albumin to do so), as well as the impact it can have if we do not, is often met in resounding agreement from surgeons and other

healthcare professionals alike that change is needed. I hope to keep up this momentum and continue to read, learn, research and implement policy changes in the future, for the benefit of surgical patients.

## 7.8 Chapter summary

- This thesis presents novel findings which can be used as a springboard to influence surgeons, policy makers and researchers.
- There is a need for a change in surgical culture at surgeon- and institutional-level around nutrition in EGS to ensure malnourished patients receive the support they need. Recognising it is important and can impact patient outcomes is not enough. Surgeons need to take ownership of their own learning and engage with research about nutrition in EGS.
- Policy makers must aim to bridge these knowledge gaps by developing courses and implementing guidelines. They should define the roles and responsibilities of healthcare professionals involved in identifying malnourished patients and providing nutritional support. There must be improved organisational support to provide the best nutritional care to patients when they need it, driven by prospectively maintained datasets and research.
- This thesis presents six studies which have the potential to broaden our understanding of how best to identify and manage malnourished EGS patients. These include a service mapping exercise, understanding the needs of EGS patients, applying the latest guidelines to current practice, and an appraisal of the evidence which may help inform a future research trial.
- The design of this mixed methods research with its multi-faceted approach and recruitment of surgeons at different levels of seniority and experience of IF is its major asset. However, selection bias, the complexity of EGS research and the absence of patient and public involvement may limit the external validity of the findings.

## 7.9 Conclusion

In emergency general surgery, malnutrition is a common but reversible risk factor for adverse surgical outcomes. Identifying malnourished EGS patients is difficult but paramount to potentially mitigating the patient and organisational costs. This thesis aimed to examine the similarities/ differences in how surgeons identify malnourished EGS patients in the UK, and understand why any differences exist. It used a mixed methods approach consisting of five studies to explore this issue. It showed there is inconsistency in how surgeons identify malnourished EGS patients in research and clinical practice and this is influenced by institutional factors. Together, these can alter decision making on timing of nutritional support and operative outcomes. This thesis does not recognise or recommend a single 'right way' to identify malnourished EGS patients. However, it does demonstrate an urgent need to improve how it is currently performed. Twenty-one key findings are highlighted.

# Appendices

## Appendix 1

This section includes:

- Additional files to support Paper 1
  - **Additional File 1:** Example search strategy for Medline
- Supplementary tables for Paper 1
  - **Table S1:** Summary characteristics of each included study
  - **Table S2:** A summary of single centre prospective studies
  - **Table S3:** A summary of multicentre prospective studies
  - **Table S4:** A summary of single centre retrospective studies
  - **Table S5:** A summary of multicentre retrospective studies
  - **Table S6:** A summary of a single centre study (not stated if retrospective or prospective)
  - **Table S7:** Criteria used in defining malnutrition according to 'core areas'



## Additional files to support Paper 1

### Additional file 1: Example search strategy for MEDLINE

- 1 exp Acute Disease/ (218603)
- 2 exp Emergencies/ (42306)
- 3 exp Emergency Service, Hospital/ (91083)
- 4 exp Surgery Department, Hospital/ (4557)
- 5 emergenc\*.mp. (503997)
- 6 1 or 2 or 3 or 4 or 5 (720310)
- 7 exp General Surgery/ (40102)
- 8 exp Surgical Procedures, Operative/ (3369162)
- 9 General surg\*.mp. (56033)
- 10 Surgery.mp. (2853383)
- 11 Abdom\* surgery {Including Related Terms} (20903)
- 12 7 or 8 or 9 or 10 or 11 (4464105)
- 13 Laparotom\*.mp. (62246)
- 14 (Celiotom\* or coeliotom\*).mp. (1369)
- 15 13 or 14 (63412)
- 16 Critical Care/ (57200)
- 17 Critical care {No Related Terms} (10095)
- 18 16 or 17 (58206)
- 19 12 or 15 or 18 (4523457)
- 20 6 and 19 (161313)
- 21 exp Nutrition Assessment/ (16651)
- 22 exp Nutritional Status/ (50027)
- 23 exp Malnutrition/ (129082)
- 24 Nutrition\* risk {Including Related Terms} (7523)
- 25 Nutrition\* assessment {Including Related Terms} (9443)
- 26 Nutrition\* screening {Including Related Terms} (7198)
- 27 Nutrition index {Including Related Terms} (320)
- 28 Malnutrition {Including Related Terms} (10751)
- 29 Screening tool\* {Including Related Terms} (52006)
- 30 Nutritional\* deficienc\* {Including Related Terms} (10751)
- 31 Malnutrition Screening Tool {Including Related Terms} (365)

- 32 MST {Including Related Terms} (6718)
- 33 Malnutrition Universal Screening Tool {Including Related Terms} (9611)
- 34 Global Leadership initiative on Malnutrition {Including Related Terms} (9262)
- 35 GLIM {Including Related Terms} (295)
- 36 Nutrition Risk Screening {Including Related Terms} (9314)
- 37 NRS {Including Related Terms} (3774)
- 38 Mini Nutritional Assessment {Including Related Terms} (7718)
- 39 MNA {Including Related Terms} (2528)
- 40 Mini Nutritional Assessment-Short Form {Including Related Terms} (9667)
- 41 MNA-SF {Including Related Terms} (425)
- 42 Subjective Global Assessment {Including Related Terms} (1693)
- 43 SGA {Including Related Terms} (9788)
- 44 Nutrition Risk in Critically ill {Including Related Terms} (7844)
- 45 NUTRIC {Including Related Terms} (96)
- 46 Modified Nutrition Risk in Critically ill {Including Related Terms} (7763)
- 47 mNUTRIC {Including Related Terms} (55)
- 48 Nutrition Risk Index {Including Related Terms} (7947)
- 49 NRI {Including Related Terms} (1912)
- 50 Geriatric Nutrition Risk Index {Including Related Terms} (46)
- 51 GNRI {Including Related Terms} (403)
- 52 Short nutrition assessment questionnaire {Including Related Terms} (9117)
- 53 SNAQ {Including Related Terms} (145)
- 54 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37  
or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53  
(307047)
- 55 20 and 54 (1092)
- 56 limit 55 to (english language and yr="2000 -Current") (859)

## Supplementary tables for Paper 1

**Table S1:** Summary characteristics of each included study

| Author & Year                                                          | Hospital setting | Setting     | Multicentre | Mean age, years (range) | EGS/ Total patients, % (n) | Laparotomy frequency (%) | Malnutrition defined | Nutrition measure studied*                                                   |
|------------------------------------------------------------------------|------------------|-------------|-------------|-------------------------|----------------------------|--------------------------|----------------------|------------------------------------------------------------------------------|
| <b>Barazanchi et al., 2020</b><br>(278)                                | NS               | Australasia | No          | 62 (18-96)              | 94.6 (717/758)             | 100.0                    | No                   | 6-month weight loss<br>Reduction in appetite                                 |
| <b>Byrnes et al., 2018</b> (281)                                       | Ward             | Australasia | No          | 74 (NS)                 | 58.7 (44/75)               | NS                       | Yes                  | Screening: MST and HGS<br>Assessment: PG-SGA<br><i>Weight, BMI</i>           |
| <b>Chua and Chan, 2020</b> (279)                                       | Ward/ ICU        | Asia        | No          | 60.5 (NS)               | 100.0 (170/170)            | 100.0                    | Yes                  | Screening: (3-Min NS)<br>Assessment: SGA<br><i>BMI, albumin</i>              |
| <b>Daniele et al., 2015</b> (273)                                      | NS               | Europe      | No          | 63 (24-79)              | 55.0 (22/40)               | NS                       | Yes                  | PG-SGA<br><i>BMI, total serum protein, albumin, CRP</i>                      |
| <b>Farrah et al., 2013</b> (286)                                       | Ward/ ICU        | N. America  | No          | 58.9 (NS)               | 100.0 (231/231)            | NS                       | No                   | Albumin                                                                      |
| <b>Fentahun, Netsanet and Menber, 2021</b> (261)                       | NS               | Africa      | Yes         | 39.7 (NS)               | 51.3 (159/310)             | 39.4                     | Yes                  | BMI or albumin                                                               |
| <b>Fernandes et al., 2019</b> (274)                                    | ICU              | Europe      | No          | 64.5 (47–81)            | 60.0 (36/60)               | 68.3                     | Yes                  | Albumin<br><i>BMI</i>                                                        |
| <b>Fuertes-Guiró, Vitali-Erion and Rodriguez Fernandez, 2019</b> (283) | Ward             | Europe      | No          | 78.6 (NS)               | 100.0 (286/286)            | NS                       | Yes                  | MNA SF<br><i>Albumin, skeletal muscular mass (measured via bioimpedence)</i> |
| <b>Haines et al., 2021</b> (262)                                       | NS               | N. America  | Yes         | 61.4 (NS)               | 100.0 (31029/31029)        | NS                       | Yes                  | mGLIM                                                                        |

|                                                   |           |            |     |                |                     |       |     |                                                                                                                                |
|---------------------------------------------------|-----------|------------|-----|----------------|---------------------|-------|-----|--------------------------------------------------------------------------------------------------------------------------------|
| <b>Havens et al., 2018</b> (7)                    | ICU       | N. America | No  | 61 (NS)        | 100.0 (1361/1361)   | NS    | Yes | Weight loss, ideal weight, muscle wasting, oedema, intake, clinical judgement, biochemical markers (albumin, TLC, transferrin) |
| <b>Ho et al., 2015</b> (263)                      | NS        | Asia       | Yes | 65.9 (19-95)   | 40.3 (380/943)      | NS    | Yes | C-MUST                                                                                                                         |
| <b>Jia et al., 2020</b> (264)                     | NS        | N. America | Yes | 75 (IQR 69-82) | 100.0 (82725/82725) | NS    | Yes | GNRI, albumin or BMI                                                                                                           |
| <b>Kenig et al., 2012</b> (275)                   | Ward/ ICU | Europe     | No  | 66.8 (NS)      | 80.4 (45/56)        | 100.0 | Yes | Albumin or weight loss or BMI                                                                                                  |
| <b>Kenig et al., 2015</b> (293)                   | Ward      | Europe     | No  | 76.9 (65-100)  | 100.0 (184/184)     | NS    | No  | G8<br><i>Albumin</i>                                                                                                           |
| <b>Khan, Ahmed and Safdar, 2016</b> (265)         | NS        | Asia       | No  | NS (15-60)     | 100.0 (200/200)     | 20    | Yes | BMI                                                                                                                            |
| <b>Mäkelä, Kiviniemi and Laitinen, 2005</b> (285) | NS        | Europe     | No  | 81.5 (NS)      | 100.0 (218/218)     | NS    | Yes | Albumin and weight loss<br><i>BMI</i>                                                                                          |
| <b>Mäkelä, Kiviniemi and Laitinen, 2005</b> (284) | NS        | Europe     | No  | 65 (28-99)     | 100.0 (172/172)     | 95.9  | Yes | Albumin and weight loss<br><i>BMI</i>                                                                                          |
| <b>Koziel et al., 2017</b> (266)                  | N/A       | Europe     | No  | 54.4 (NS)      | 100.0 (150/150)     | NS    | Yes | SGA, BMI, albumin, TNL, AMC                                                                                                    |
| <b>Krishna et al., 2019</b> (276)                 | NS        | Asia       | No  | 52 (NS)        | 100.0 (30/30)       | 100.0 | Yes | Albumin                                                                                                                        |
| <b>Küpper et al., 2015</b> (104)                  | Ward/ ICU | N. America | No  | 53 (17–85)     | 100.0 (111/111)     | 35.1  | No  | BMI                                                                                                                            |
| <b>Lalhruaizela et al., 2020</b> (267)            | NS        | Asia       | No  | 48.3 (19-70)   | 68.7 (68/99)        | 100.0 | No  | MUAC, skin fold thickness and BMI                                                                                              |
| <b>Mambou Tebou et</b>                            | NS        | Africa     | No  | 34.9 (19-50)   | 67.1 (57/85)        | NS    | Yes | NRI/ Buzby index<br><i>BMI, albumin</i>                                                                                        |

|                                                    |           |            |     |              |                 |       |     |                                                                                   |
|----------------------------------------------------|-----------|------------|-----|--------------|-----------------|-------|-----|-----------------------------------------------------------------------------------|
| <i>al.,</i><br><b>2017</b> (268)                   |           |            |     |              |                 |       |     |                                                                                   |
| <b>Mohil et al.,</b><br><b>2008</b> (269)          | NS        | Asia       | No  | 33 (13-75)   | 100.0 (101/101) | 100.0 | Yes | PNI or SGA                                                                        |
| <b>Novy et al.,</b><br><b>2021</b> (280)           | Ward/ ICU | Europe     | Yes | 83 (79-89)   | 100.0 (180/180) | NS    | Yes | BMI, weight loss and albumin                                                      |
| <b>Sánchez Acedo et al.,</b><br><b>2020</b> (287)  | NS        | Europe     | No  | 78 (65-103)  | 100.0 (446/446) | NS    | No  | MNA SF                                                                            |
| <b>Saravana-Bawan et al.,</b><br><b>2021</b> (270) | NS        | N. America | Yes | 74.6 (NS)    | 100.0 (684/684) | NS    | Yes | CNST                                                                              |
| <b>Serejo et al.,</b><br><b>2007</b> (288)         | NS        | S. America | No  | 36.5 (NS)    | 100.0 (266/266) | NS    | No  | BMI                                                                               |
| <b>Takano et al.,</b><br><b>2021</b> (271)         | NS        | Asia       | No  | 80.1 (NS)    | 100.0 (60/60)   | NS    | Yes | Cholinesterase<br><i>PNI, mGPS, albumin</i>                                       |
| <b>Waqar et al.,</b><br><b>2005</b> (277)          | NS        | Asia       | No  | 39.7 (13-78) | 36.8 (43/117)   | 100.0 | No  | NS<br><i>Obesity</i>                                                              |
| <b>Weiss et al.,</b><br><b>2020</b> (282)          | Ward/ ICU | N. America | No  | 78.6 (NS)    | 58.1 (137/236)  | NS    | Yes | Albumin (as part of Trauma and Emergency General Surgery Frailty Index (TEGS FI)) |
| <b>Welch et al.,</b><br><b>2022</b> (272)          | Ward      | Europe     | No  | 79.2 (NS)    | 19.8 (16/81)    | 14.8  | Yes | MNA<br><i>BMI</i>                                                                 |

Abbreviations: 3-minute nutrition screening (3-Min NS); arm muscle circumference (AMC); body mass index (BMI); Canadian Nutrition Screening Tool (CNST); emergency general surgery (EGS); Geriatric 8 (G8); Geriatric Nutrition Risk Index (GNRI); hand grip strength (HGS); Hong Kong Chinese Malnutrition Universal Screening Tool (C-MUST); intensive care unit (ICU); Malnutrition Screening Tool (MST); mean upper arm circumference (MUAC); Mini Nutritional Assessment (MNA); Mini Nutritional Assessment short form (MNA SF); modified Glasgow prognostic score (mGPS); modified Global Leadership Initiative on Malnutrition (mGLIM); not applicable (N/A); not stated (NS); Nutrition Risk Index (NRI); Patient Generated Subjective Global Assessment (PG-SGA); Prognostic Nutrition Index (PNI); Subjective Global Assessment (SGA); total leucocyte count (TLC); total number of lymphocytes (TNL). \*in addition to the main nutrition measure studied, other nutritional measures included in the study are italicised.

**Table S2:** A summary of single centre prospective studies

| Author, year, setting                                          | Inclusion and exclusion criteria                                                                                                                                                                                                                                                                        | Mean age, years (range) | EGS patients, % (n EGS/ total) | Measurement tool & malnourished EGS patients, % (n)                                                                                                                                                           | Study aim                                                                                                                                                                                                                                             | Primary outcome                                                                                                                                                                                                                                                                                  | Main nutrition outcome                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Byrnes <i>et al.</i> , 2018(281)                               | Inclusion: ≥65 years; length of stay ≥72 hours; not critically ill or palliated; can obtain informed consent<br><br>Exclusion: Unable to complete the test, or condition causing reduced hand function                                                                                                  | 74 (NS)                 | 58.7 (44/75)                   | <u><b>EGS &amp; elective: MST/ HGS</b></u><br>MST: 32.0 (24/75)<br>MST ≥2 and HGS: 13.3 (10/75)<br><br><u><b>EGS only: PG-SGA</b></u><br>PG-SGA B 18.2 (8/44)<br>PG-SGA C 2.3 (1/44)<br>EGS Total 20.5 (9/44) | To determine discriminatory ability of HGS in screening for malnutrition as assessed by the PG-SGA and assess the added value of combining this with the MST.                                                                                         | HGS is not suitable in screening older inpatients for malnutrition during admission to surgical wards, nor does it increase the discriminatory ability of the MST.                                                                                                                               | As primary outcome                                                                                                                                                                                                                                                                                                  |
| Fuertes-Guiró, Vitali-Erion and Rodriguez Fernandez, 2019(283) | Inclusion: >65 years old diagnosed with urgent abdominal pathology and requiring immediate or urgent surgical treatment.<br><br>Exclusion: Inter- and intra-hospital ward transfers; previous elective surgery; transplants; unable to perform predictive tests; died during preoperative stabilisation | 78.6 (NS)               | 100.0 (286/ 286)               | <u><b>MNA SF</b></u><br>Malnourished 29.4 (84/286)<br>At Risk 31.6 (91/286)<br>Normal 38.9 (111/286)                                                                                                          | To assess frailty in a holistic context as a prognostic factor for the outcomes of geriatric patients undergoing emergency abdominal surgery, identifying the predictors that could be included in a global assessment score of preoperative frailty. | Frailty is a predictive factor that should be used routinely in geriatric EGS in a holistic context since no predictor is able to predict all the selected variables alone. The MNA SF, sarcopenia, Pfeiffer, Barthel and Duke tests best predict outcomes after emergency surgery.              | There is an association of postoperative mortality and patients at risk of malnutrition (OR 1.89, p 0.032), in those who are malnourished (OR 1.57, p 0.14), low albumin (OR 2.94, p 0.038), low SMM (OR 2.78, p 0.022). Mortality 3 months after hospital discharge is associated with low SMM (OR 1.78, p 0.035). |
| Kenig <i>et al.</i> , 2015(293)                                | Inclusion: ≥65 years needing emergency abdominal surgery<br><br>Exclusion: Unable to consent; immediate operation; incarcerated hernia with no laparotomy; operated >24 h after admission; abdominal wall infections; acute pancreatitis; patients managed endoscopically                               | 76.9 (65-100)           | 100.0 (184/ 184)               | <u><b>G8</b></u><br>NS                                                                                                                                                                                        | To compare the diagnostic accuracy of six screening instruments in predicting frailty and postoperative morbidity and mortality.                                                                                                                      | The VES-13 was the best screening instrument; it had the highest sensitivity and negative predictive value both for the postoperative mortality and morbidity.                                                                                                                                   | The G8 score was created based on the MNA and the major cause of frailty is the anorexia of aging, leading to protein energy malnutrition. Only 4 patients (11.4%) with fatal outcome were in good nutrition.                                                                                                       |
| Koziel <i>et al.</i> , 2017(266)                               | Inclusion: Severe acute pancreatitis (mild acute pancreatitis acted as control)<br><br>Exclusion: A moderate course of acute pancreatitis; chronic pancreatitis                                                                                                                                         | 54.4 (NS)               | 100.0 (150/ 150)               | <u><b>SGA</b></u><br>SAP<br>Normal 83.8 (85/99)<br>Malnourished 14.1 (14/99)<br><br>MAP<br>Normal 96.1 (49/51)<br>Malnourished 3.9 (2/51)                                                                     | To evaluate pancreatic morphology and function, as well as nutritional status and quality of life among patients who experienced severe acute pancreatitis.                                                                                           | One year after SAP, patients exhibited changes in pancreatic morphology and carbohydrate metabolism disorders. Exocrine insufficiency equally among patients with severe or mild AP. The majority of QOL domains did not differ between patient groups. Patients with SAP described their mental | A medium risk of malnutrition (SGA B) was observed in 16.2% (16) of patients after SAP vs. 2% (1) of patients after MAP (p=0.01).<br><br>No patients with SAP were classified as having SGA C vs one patient after MAP.                                                                                             |

|                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                |                                                                                                                                                                                                                             |                                                                                                                                                                                                |                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                 |
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|                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                | Additional results exist for BMI, albumin, TNL and AMC but these are not significant like SGA.                                                                                                                              |                                                                                                                                                                                                | health in more negative terms than patients with MAP (p<0.05).                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                 |
| Krishna <i>et al.</i> , 2019(276)      | Inclusion: RL performed within 60 days of an initial laparotomy for complications arising following the primary surgery<br><br>Exclusion: Elective RL, index laparotomy performed in other hospital, damage control laparotomy, minimally invasive surgery                                                                                                                                                                                                                             | 52 (NS)      | 100.0 (30/ 30) | <u>Pre-operative serum albumin levels</u><br>53.3 (16/30)                                                                                                                                                                   | To determine the incidence, indications, and outcome of RLs and identify factors affecting mortality and outcomes of RLs in Indian population.                                                 | RL was more common in emergency surgeries (80% vs 20%). The mean hospital stay was 25.8 days. The mean interval between first laparotomy and RL was 12.3 days and the interval between time of detection of the complication and RL was 3.96 days. | Mean serum albumin was 3.4 g/dL (range 2.2-4.3 g/dL). Mean albumin associated with mortality was 3.01. Five of seven patients (71%) who underwent RL for anastomotic dehiscence had hypoalbuminemia and four out of six patients (66%) undergoing RL for burst abdomen had hypoalbuminemia.                                                     |
| Lalhruaizela <i>et al.</i> , 2020(267) | Inclusion: >18 years with pre-operative albumin level <3 g/dL; emergency and elective laparotomy for GI diseases<br><br>Exclusion: albumin ≥3.0 g/dL, clinically significant hypoalbuminemia; sepsis; jaundice; haemoglobin <8g/dL; PMH or FHx of T2DM/ CLD/ CKD/ hepatitis; protein-losing enteropathy/ nephrotic syndrome/ analbuminemia/ UC/ CF/ HF/ amyloidosis; taking steroids, hepatotoxic drugs, chemotherapy; BMI <12 or >40; alcohol or tobacco addiction; lost at follow-up | 48.3 (19-70) | 68.7 (68/99)   | <u>BMI, MUAC and skin fold thickness</u><br>Unknown as no criteria given                                                                                                                                                    | To determine the relationship between hypoalbuminemia (<3g/dL) and developing complications and mortality following laparotomy for GI diseases for both emergency and elective surgeries.      | Pre-operative Hypoalbuminemia <3.0 gm/dL is a strong and independent risk factor for post-operative morbidity and mortality in GI surgeries and BMI is a strong indicator for post-operative complications.                                        | The relationship of BMI and rate of complication was found to be statistically significant (p = 0.0001). Patients with BMI <18.5 kg/m <sup>2</sup> had a complication rate of 89% (44/49). Patients with a BMI between 18.5-24.9 kg/m <sup>2</sup> had a complication rate of was 26.7% (12/45) and 60% (3/5) between 25-30 kg/m <sup>2</sup> . |
| Mambou Tebou <i>et al.</i> , 2017(268) | Inclusion: Consenting adults aged 19-59 years, either in the preoperative or postoperative period of abdominal surgery<br><br>Exclusion: Patients with GI malignancies                                                                                                                                                                                                                                                                                                                 | 34.9 (19-50) | 67.1 (57/85)   | NS; figures for all patients <u>NRI</u><br>Pre-op:<br>Moderately malnourished 30.4 (7/23)<br>Severely malnourished 8.7 (2/23)<br><br>Post-op:<br>Moderately malnourished 43.5 (37/85)<br>Severely malnourished 23.5 (20/85) | To assess the perioperative nutritional status of patients undergoing abdominal surgery and to determine the relationship between perioperative nutritional status and postoperative outcomes. | The prevalence of malnutrition is high and is associated with an increased risk of adverse early postoperative outcomes. Routine nutritional assessment and management is recommended.                                                             | The following were associated with a 'normal evolution': normal postoperative BMI [OR (95% CI) = 2.9 (1.19–7.34), p = 0.018]; normal postoperative albumin [OR (95% CI) = 55 (13.49–224.32), p < 0.001] and normal NRI [OR (95% CI) = 19.3 (2.18–169.79), p = 0.003].                                                                           |

|                                         |                                                                                                                                                                                                                                                     |                                       |                  |                                                                                                                                                                                                                          |                                                                                                                                                                             |                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                      |
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| Mohil <i>et al.</i> , 2008(269)         | <p>Inclusion: NS</p> <p>Exclusion: Patients transferred postoperatively; uncomplicated acute appendicitis; early postoperative death; prolonged ventilatory support postoperatively, leaving hospital against medical advice</p>                    | 33 (13-75)                            | 100.0 (101/ 101) | <p><b><u>PNI</u></b></p> <p>Low risk 20.8 (21/101)<br/>Intermediate risk 14.9 (15/101)<br/>High risk 64.4 (65/101)</p> <p><b><u>SGA</u></b></p> <p>SGA A 40.6 (41/101)<br/>SGA B 52.5 (53/101)<br/>SGA C 6.9 (7/101)</p> | To study the association between nutritional status, morbidity, mortality and severity scores (POSSUM, P-POSSUM and APACHE II) in patients undergoing emergency laparotomy. | A majority of the patients had poor nutritional status on admission by both the nutritional assessment tools. With the onset of acute emergency, there was a significant relation of nutritional status with disease severity, morbidity and mortality. | SGA appears to be better assessing the pre-existing nutritional state. SGA was significantly associated with mortality, disease severity and overall morbidity (wound infection or dehiscence, anastomotic leak and chest infection). PNI significantly associated with wound dehiscence or infection and respiratory complications. |
| Sánchez Acedo <i>et al.</i> , 2020(287) | <p>Inclusion: aged ≥65 years who had undergone urgent abdominal surgery</p> <p>Exclusion: NS</p>                                                                                                                                                    | 78 (65-103)                           | 100.0 (446/ 446) | <p><b><u>MNA SF</u></b></p> <p>No malnutrition 93.3 (415/445)<br/>Malnutrition 6.7 (30/445)</p>                                                                                                                          | To analyse the incidence and factors associated with postoperative delirium in patients aged ≥65 who underwent urgent abdominal surgery.                                    | Post-operative incidence of delirium was 13.6%, and was significantly associated with age, ASA III, physiological alteration in the ED, preoperative diagnosis, intestinal ischaemia and previous cognitive deterioration                               | Nutritional status (and comorbidity, frailty, functional dependence) were not statistically associated with delirium. Nourished and delirious patients 12.5% (52/415), whilst malnourished and delirious 26.7% (8/30).                                                                                                               |
| Serejo <i>et al.</i> , 2007(288)        | <p>Inclusion: Adults undergoing emergency abdominal surgery</p> <p>Exclusion: diagnosis of NMD or acute respiratory condition on initial evaluation; extra-abdominal injuries; re-operations</p>                                                    | 36.5 (NS)                             | 100.0 (266/ 266) | <p><b><u>BMI</u></b></p> <p>‘Eutrophic’: ≥21 kg/m<sup>2</sup> - &lt;30 kg/m<sup>2</sup> 77.1 (205/266)</p> <p>‘Dystrophic’: BMI &lt;21 kg/m<sup>2</sup> or ≥30 kg/m<sup>2</sup> 22.9 (61/266)</p>                        | The aim of this study was to determine the incidence and predictors of pulmonary complications following emergency abdominal surgery.                                       | PPC developed in 75 patients (28.2%): 44 pneumonia, 16 atelectasis, 9 pleural effusion and 6 acute respiratory failure. ‘Dystrophic’ BMI, advanced age, type of incision were independent predictors of PPC.                                            | <p>Eutrophic: 24.9% (51/205) developed PPC. Crude OR = 1.95 (95% CI = 1.07–3.58; p value = 0.029)</p> <p>Dystrophic 40% (24/61) developed PPC.</p>                                                                                                                                                                                   |
| Waqar <i>et al.</i> , 2005(277)         | <p>Inclusion: Adults undergoing laparotomy for various indications</p> <p>Exclusion: NS</p>                                                                                                                                                         | 39.7 (13-78)                          | 36.3 (43/117)    | <p><b><u>Malnutrition measure NS</u></b></p> <p>Obesity 12.8 (15/117)<br/>Malnourished 19.7 (23/117)</p>                                                                                                                 | To determine the frequency and risk factors of wound dehiscence/ burst abdomen in patients undergoing emergency and elective laparotomies through midline incisions         | Incidence of wound dehiscence was 6.0% (7/117) and is statistically significant when comparing emergency vs elective surgery.                                                                                                                           | With respect to wound dehiscence, 13.3% (2/15) patients were obese and 13.0% (3/23) were malnourished.                                                                                                                                                                                                                               |
| Welch <i>et al.</i> , 2022(272)         | <p>Inclusion: ≥70 years in three cohorts: elective colorectal surgery, emergency abdominal surgery, medical patients with infections</p> <p>Exclusion: unable to understand English or mobilise prior to admission; life expectancy &lt;30 days</p> | <p>79.2 (NS)</p> <p>75.5 (NS) EGS</p> | 19.8 (16/81)     | <p><b><u>MNA</u></b></p> <p>Normal ≥24 40 (6/15)<br/>At risk 17-23.5 60 (9/15)<br/>Malnourished &lt;17 0 (0/15)</p>                                                                                                      | To assess the feasibility of conducting acute sarcopenia research in complex populations of hospitalised older adults.                                                      | Recruitment rates were higher in elective surgery patients compared to EGS or medical patients. Drop-out rates were not affected by age or frailty of participants. Completion rates of ultrasound quadriceps were higher than other procedures.        | As primary outcome                                                                                                                                                                                                                                                                                                                   |



Abbreviations: Arm muscle circumference (AMC); body mass index (BMI); chronic kidney disease (CKD); chronic liver disease (CLD); cystic fibrosis (CF); emergency department (ED); emergency general surgery (EGS); family history (FHx); Gastrointestinal (GI); Geriatric 8 (G8); hand grip strength (HGS); heart failure (HF); intensive care unit (ICU); Malnutrition Screening Tool (MST); Mini Nutritional Assessment short form (MNA SF); neuromuscular disease (NMD); not stated (NS); Nutrition Risk Index (NRI); odds ratio (OR); past medical history (PMH); Patient Generated Subjective Global Assessment (PG-SGA); Prognostic Nutrition Index (PNI); quality of life (QOL); relook laparotomy (RL); Severe acute pancreatitis (SAP); skeletal muscle mass (SMM); Subjective Global Assessment (SGA); total number of lymphocytes (TNL); type 2 diabetes mellitus (T2DM); ulcerative colitis (UC); Vulnerable Elderly Survey-13 (VES-13).

**Table S3:** A summary of multicentre prospective studies

| Author, year                             | Inclusion and exclusion criteria                                                                                                                                                                                                     | Mean age, years (range) | EGS patients, % (n EGS/ total) | Measurement tool & malnourished EGS patients, % (n)                                                                                                                                                            | Study aim                                                                                                                                                                                                                                                                          | Primary outcome                                                                                                                                                                        | Main nutrition outcome                                                                                                                                                                           |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fentahun, Netsanet and Menber, 2021(261) | Inclusion: ≥18 years undergoing abdominal surgery; a proportional systematic sampling technique was used based on the last four-month abdominal surgical operation reports<br><br>Exclusion: NS                                      | 39.7 (NS)               | 51.3 (159/310)                 | <b>BMI</b><br>50.0 (155)<br><br><b>Albumin</b><br>44.8 (139)                                                                                                                                                   | To assess the association between nutritional status and wound healing progress                                                                                                                                                                                                    | Nutritional status had a strong association with good wound healing outcomes                                                                                                           | As primary outcome Well-nourished patients were 2x (BMI) and 1.6 (albumin) more likely to have better wound healing than malnourished patients.                                                  |
| Ho <i>et al.</i> , 2015(263)             | Inclusion: Chinese adult surgical patients undergoing elective and emergency operations on the luminal gastrointestinal tract; can give informed verbal consent<br><br>Exclusion: NS                                                 | 65.9 (19-95)            | 40.3 (380/943)                 | <b>C-MUST</b><br>EGS NS<br><br><b>EGS and non-EGS:</b><br>Low risk 67.1 (633/943)<br>Medium risk 15.8 (149/943)<br>High 17.1 (161/943)                                                                         | To determine the preoperative malnutrition risk of patients undergoing major and ultramajor gastrointestinal operations using the C-MUST and to correlate the nutritional risk with surgical outcomes as captured by the surgical outcomes monitoring and improvement program      | EGS results:<br>Length of stay 19.4 days<br>30-day mortality 6.8%<br>60-day mortality 11.1%                                                                                            | Note this is based on elective and EGS patients: increasing malnutrition risk was an independent predictor of length of stay, 30-day mortality, 60-day mortality and minor medical complications |
| Saravana-Bawan <i>et al.</i> , 2021(270) | Inclusion: ≥ 65 years; index admission; postoperative acute abdominal surgery<br><br>Exclusion: elective surgery; palliative surgery; trauma surgery; non-abdominal EGS; nursing home residents; inter- and intra-hospital transfers | 74.6 (NS)               | 100.0 (684/ 684)               | <b>CNST</b><br>6 week post-discharge at risk of malnutrition<br>Control site<br>Pre-EASE 61.9 (39/63)<br>Post-EASE 37.5 (42/112)*<br><br>Intervention site<br>Pre-EASE 35.8 (34/95)<br>Post-EASE 27.5 (28/102) | To assess post-discharge patient reported outcomes regarding nutrition and QOL following the introduction of an Acute Care for the Elderly (ACE) model of care in an EGS population (secondary outcomes of the Elder-friendly Approaches to the Surgical Environment (EASE) study) | The clinically and economically beneficial EASE interventions do not appear to compromise quality of life, risk for malnutrition, or patient satisfaction in the post-discharge period | There was a statistically significant improvement in malnutrition risk over time at control and intervention sites both pre- and post-EASE                                                       |

Abbreviations: Acute Care for the Elderly (ACE); body mass index (BMI); Canadian Nutrition Screening Tool (CNST); Elder-friendly Approaches to the Surgical Environment (EASE); emergency general surgery (EGS); Hong Kong Chinese Malnutrition Universal Screening Tool (C-MUST); not stated (NS). \*study reports this as 52% (n = 42).

**Table S4:** A summary of single centre retrospective studies

| Author, year                         | Inclusion and exclusion criteria                                                                                                                                                                                                                                                                                  | Mean age, years (range) | EGS patients, % (n EGS/ total) | Measurement tool & malnourished EGS patients, % (n)                                                                 | Study aim                                                                                                          | Primary outcome                                                                                                                                                                                                                  | Main nutrition outcome                                                                                                                                                     |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Barazanchi <i>et al.</i> , 2020(278) | Inclusion criteria: EGS during acute admission or reoperation following complications post- elective surgery<br><br>Exclusion criteria: Obstetric/ gynaecological, aortic/ iliac, cholecystectomies, appendectomies, and trauma<br>* Identical to UK NELA criteria                                                | 62 (18-96)              | 94.6 (717/758)                 | <u>Appetite and weight loss</u><br>NS                                                                               | To assess the most commonly used risk prediction tools for EL                                                      | NELA risk prediction tool to be most predictive of mortality after EL, when compared with the currently used risk prediction tools in EL (P-POSSUM, APACHE-II, ACS-NSQIP)                                                        | The NELA, along with the three other risk prediction tools, can potentially be improved through the addition of measures of patient nutritional status and frailty         |
| Chua and Chan, 2020(279)             | Inclusion criteria: Patients undergoing a laparotomy (clinical decision)<br><br>Exclusion criteria: <18 years                                                                                                                                                                                                     | 60.5 (NS)               | 100.0 (170/170)                | <u>3-Min NS</u><br>cut off (≥3): 21.2 (33)<br><br><u>SGA</u><br>SGA A 60.0 (78)<br>SGA B 38.5 (50)<br>SGA C 1.5 (2) | Compare the outcomes of elderly patients undergoing EL against the outcomes of non-elderly patients                | Elderly patients suffer worse morbidity (LOS, ICU LOS, post-op complications) and mortality following emergency laparotomy                                                                                                       | Despite a trend for malnutrition, the global 3-MinNS score and global SGA did not differ significantly between elderly and non-elderly patients (some component parts did) |
| Daniele <i>et al.</i> , 2015(273)    | Inclusion criteria: Patients with recurrent ovarian cancer who experienced bowel obstruction<br><br>Exclusion criteria: Patients BO for other gynecological malignancies, non-epithelial or borderline ovarian cancer, BO for benign causes, previous or concurrent malignancy, concomitant recto-vaginal fistula | 63 (24-79)              | 55.0 (22/40)                   | <u>PG-SGA</u><br>NS                                                                                                 | Describe and to compare medical and surgical approaches in the management (survival, QOL) of MBO in ovarian cancer | Surgery has to be considered in patients without serious contraindications; otherwise, a combination of opioids, anti-emetics, corticosteroids, and anti-secretory drugs is the mainstay in patients with poor general condition | Cachexia, low performance status, and poor nutritional status were significant predictors of worse survival after MBO, independently by the treatment                      |
| Farrah <i>et al.</i> , 2013(286)     | Inclusion criteria: Patients undergoing gastrointestinal resection with intestinal anastomoses<br><br>Exclusion criteria: trauma patients and patients who underwent primary enterotomy/ perforation repair, or had colostomy creation without creation of anastomosis                                            | 58.9 (NS)               | 100.0 (231/231)                | <u>Albumin</u><br>NS                                                                                                | Anastomotic failure rate                                                                                           | There was an anastomotic failure rate of 11.1%, significantly more so in the stapled (15%) versus the hand sewn group (6.1%)                                                                                                     | Mean admission albumin was shown to be statistically significant in the anastomotic failure group (mean 3.1) versus the no complication group (mean 3.5)                   |

|                                           |                                                                                                                                                                                                                                                                                              |                                                |                   |                                                                                                                                                                                                                                                                   |                                                                                                                                                 |                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                               |
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| Fernandes <i>et al.</i> , 2019(274)       | Inclusion criteria: Surgical complexity level 4 and 5 according to the L. R. Pasternak classification and severity criteria<br><br>Exclusion criteria: NS                                                                                                                                    | 64.5 (47–81)                                   | 60.0 (36/60)      | <u>Albumin</u><br>NS                                                                                                                                                                                                                                              | To analyse the outcomes of pulmonary complications in patients post-abdominal surgery and admitted to ICU                                       | PPCs occur within 48 hours in 60% of abdominal surgical patients that need ICU care                                                                                                                                                                                                                   | Patients with a pre-operative serum albumin $\leq 3.5$ g/dL had a 19-fold greater odds of mortality within 30 days                                                                                                                                                                            |
| Havens <i>et al.</i> , 2018(8)            | Inclusion criteria: $\geq 18$ years admitted to the ICU and had an EGS procedure performed within 48 hours of admission.<br><br>Exclusion criteria: No dietitian assessment at ICU admission, planned readmissions, transplantation, procedures related to pregnancy, and psychiatric issues | 61 (NS)                                        | 100.0 (1361/1361) | <u>Disease-related weight loss, underweight status based on percent ideal body weight, muscle wasting, inadequate energy or protein intake</u><br>Malnutrition absent 32.5 (442)<br>Non-specific malnutrition 59.7 (812)<br>Protein-energy malnutrition 7.9 (107) | To determine whether pre-existing malnutrition is associated with increased risk of 90-day mortality following ICU admission among EGS patients | Mortality in-hospital and at 90 days was 10.1% and 17.9%, respectively.<br><br>Compared to patients without malnutrition, nonspecific malnutrition and protein-energy malnutrition increased the odds of 90-day mortality by 1.5-fold and 3.1-fold, respectively                                      | In critically ill patients who undergo EGS, malnutrition at ICU admission is predictive of adverse outcomes. In survivors of hospitalization, malnutrition at ICU admission is associated with increases in readmission and mortality                                                         |
| Kenig <i>et al.</i> , 2012(275)           | Inclusion criteria: Laparotomies complicated by postoperative wound dehiscence; matched to age ( $\pm 2$ -3 years), gender, underlying disease and the type of surgery performed<br><br>Exclusion criteria: NS                                                                               | 66.8 (NS)                                      | 80.4 (45/56)      | <u>BMI</u><br>Wound dehiscence group 21.4 (12/56)<br><br>Control group 14.3 (24/168)                                                                                                                                                                              | To identify the main risk factors for abdominal wound dehiscence in adults                                                                      | The most important risk factor for wound dehiscence is surgical site infection                                                                                                                                                                                                                        | Malnutrition had slightly increased odds of wound dehiscence (OR 1.2) but this was not significant                                                                                                                                                                                            |
| Mäkelä, Kiviniemi and Laitinen, 2005(285) | Inclusion criteria: $>75$ years with a diagnosis of cholecystitis<br><br>Exclusion criteria: NS                                                                                                                                                                                              | 1. 1988-1992, 81 (NS)<br>2. 1998-2002, 82 (NS) | 100.0 (218/218)   | <u>Albumin and weight loss</u><br>NS                                                                                                                                                                                                                              | To examine whether a change in treatment strategies over time has affected operation rates, morbidity and mortality                             | No difference in morbidity (44% vs 48%) or mortality (8% vs 6%). The rate of conservative management was similar (37% vs 30%), whilst the operative rate was significantly higher in period 1 (60% vs 25%). ERCPs and percutaneous cholecystostomy decreased the need for operations during period 2. | Malnutrition is an independent factor that contributes to mortality                                                                                                                                                                                                                           |
| Mäkelä, Kiviniemi and Laitinen, 2005(284) | Inclusion criteria: Patients with perforated diverticulitis<br><br>Exclusion criteria: NS                                                                                                                                                                                                    | 65 (28-99)                                     | 100.0 (172/172)   | <u>Albumin and weight loss</u><br>9.3 (16)                                                                                                                                                                                                                        | Report of 20 years' experience of acute perforated diverticulitis                                                                               | Postoperative mortality was related to age, but age is not an independent prognostic factor for morbidity or mortality among elderly patients with perforated diverticular disease.                                                                                                                   | Malnutrition is a significant risk factor for mortality in patients aged over 70 years (0.014), but not quite in under 70 years (0.052). The patients who had experienced malnutrition preoperatively ( $p = 0.009$ ) stayed longer in hospital. In total, 16/172 patients were malnourished. |
| Küpper <i>et al.</i> , 2015(104)          | Inclusion criteria: $>17$ years undergoing EGS with a BMI $\geq 35$<br><br>Exclusion criteria: Elective surgery or BMI $<35$                                                                                                                                                                 | 53 (17–85)                                     | 100.0 (111/111)   | <u>BMI</u><br>100.0 (111)                                                                                                                                                                                                                                         | To assess perioperative outcomes in obese patients undergoing EGS                                                                               | Obese patients requiring EGS are high risk for morbidity and mortality perioperatively Postoperatively, 40% (44) patients required ICU, 31% (34) required reoperation and 42% (47) had complications                                                                                                  | There was no difference between severely obese and morbidly obese patients with respect to demographics, co-morbidities, operative factors, ICU LOS, severity of complications or mortality. After adjustment, neither a                                                                      |

|                                  |                                                                                                                                                                                                                                |              |                |                             |                                                                                                                                                          |                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                 |
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|                                  |                                                                                                                                                                                                                                |              |                |                             |                                                                                                                                                          |                                                                                                                                                                                                                        | BMI of $\geq 40$ or incremental increases in BMI conferred a significant effect on in-hospital mortality                                                                                                                                                                                        |
| Takano <i>et al.</i> , 2021(271) | Inclusion criteria: Aged $\geq 65$ years and undergoing major EGS<br><br>Exclusion criteria: Patients with acute appendicitis, incarcerated hernia or acute cholecystitis, in-hospital onset, re-operations, insufficient data | 80.1 (65-95) | 100.0 (60/60)  | <u>Cholinesterase</u><br>NS | To evaluate the predictive value of preoperative serum ChE levels as a risk factor for postoperative complications in the elderly who have undergone EGS | The preoperative serum ChE level was found to be an independent risk factor for elderly patients in emergency surgery                                                                                                  | Preoperative serum ChE level may help to classify elderly patients according to their nutritional status and predict the postoperative course. ChE levels and PNI were statistically significant when comparing patients with a postoperative complication Clavien-Dindo $\geq$ grade II or not |
| Weiss <i>et al.</i> , 2020(282)  | Inclusion criteria: Patients admitted to the trauma and emergency general surgery service and were $\geq 65$ years old<br><br>Exclusion criteria: NS                                                                           | 78.6 (NS)    | 58.1 (137/236) | <u>TEGS FI</u><br>NS        | To determine how the TEGS frailty index compares to an EMR-based frailty assessment in predicting geriatric TEGS outcomes                                | Multidimensional bedside frailty assessment tools were similar to comorbidity-focused, EMR-based frailty assessment tools in identifying geriatric TEGS patients at increased risk for complications and prolonged LOS | NS                                                                                                                                                                                                                                                                                              |

Abbreviations: 3-minute nutrition screening (3-Min NS); Acute Physiology and Chronic Health Evaluation-II (APACHE-II); American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP); bowel obstruction (BO); electronic medical record (EMR); emergency laparotomy (EL); intensive care unit (ICU); length of stay (LOS); malignant bowel obstruction (MBO); National Emergency Laparotomy Audit (NELA); not stated (NS); odds ratio (OR); Portsmouth-Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (P-POSSUM); postoperative pulmonary complication (PPC); quality of life (QOL); Subjective Global Assessment (SGA); trauma and emergency surgery (TEGS) frailty index (FI) (TEGS FI); United Kingdom (UK). The Pasternak classification categorises highly invasive procedures, duration of surgery and intraoperative complications along with the usual postoperative PICU stay with invasive monitoring.

**Table S5:** A summary of multicentre retrospective studies

| Author, year                      | Inclusion and exclusion criteria                                                                                                                                                                                                                                                        | Mean age, years (range) | EGS patients, % (n EGS/ total) | Measurement tool & malnourished EGS patients, % (n)                                                                                                                                                                                                                                                                                                                                            | Study aim                                                                                                                                                                                                                    | Primary outcome                                                                                                                                                                                                                                                                                                                                                                                        | Main nutrition outcome                                                                                                                                      |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Haines <i>et al.</i> , 2021(26 2) | Inclusion criteria: EGS patients enrolled in the NSQIP database (emergent gastrointestinal surgery on small bowel, colon, and rectum)<br><br>Exclusion criteria: Patients with missing albumin data or whose levels were below 0.1 g/dL                                                 | 61.4 (NS)               | 100.0 (31029/ 31029)           | <b>mGLIM</b><br>1.7 (517)                                                                                                                                                                                                                                                                                                                                                                      | To assess the post-operative outcomes (mortality, LOS and post-operative complications) of patients meeting a modified GLIM-defined (mGLIM) malnutrition criteria undergoing EGS in the NSQIP database                       | Mortality: Colon 2.01 [1.55-2.61] (p = <0.001); small bowel 1.70 [1.08-2.67] (p = 0.022)<br><br>LOS: Colon: 3.13 [1.93-4.33] (p = <0.001); small bowel: 1.25 [0.43-2.94] (p = 0.145)<br><br>Post-operative complications: Colon 2.06 [1.61-2.62]; small bowel 2.30 [1.57-3.37] (p<0.001 for both)                                                                                                      | Malnutrition is associated with poor clinical outcomes following EGS affecting LOS and mortality                                                            |
| Jia <i>et al.</i> , 2020(26 4)    | Inclusion criteria: EGS patients enrolled in the NSQIP database (patients aged ≥65years who underwent EGS no later than 12 hours after admission or after the onset of related symptomatology)<br><br>Exclusion criteria: Patients with missing height, weight, or preoperative albumin | 75 (IQR 69-82)          | 100.0 (82725/ 82725)           | <b>GNRI</b><br>Overall: 66.74 (55214/82725)<br>Mild: 18.3 (15,164/82725)<br>Moderate: 22.5 (18851/82725)<br>Severe: 15.4 (12699/82725)<br>Very severe: 10.6 (8770/82725)<br><br><b>Albumin</b><br>Overall: 65.6 (54,259/82725)<br>Mild 15.6 (12,947/82725)<br>Moderate 19.5 (16118/82725)<br>Severe 15.0 (12420/82725)<br>Very severe 15.4 (12774/82725)<br><br><b>BMI</b><br>4.9 (4091/82725) | To determine whether preoperative malnutrition, as measured by GNRI, is independently correlated with postoperative mortality and morbidity in the elderly ES patient. To compare the performance of GNRI to BMI and albumin | Frequency (%) of 30-day mortality in relation to:<br><br><b>GNRI</b><br>Mild: 9.3 (1404/15164)<br>Moderate: 15.5 (2873/18851)<br>Severe: 24.1 (3064/12699)<br>Very severe: 38.1 (3340/8770)<br><br><b>Albumin (&lt;3.8 g/dL)</b><br>Mild: 9.0 (1167/12947)<br>Moderate: 14.3 (2298/16118)<br>Severe: 21.3 (2645/12420)<br>Very severe: 34.5 (4404/12774)<br><br><b>BMI &lt;18.5</b><br>24.1 (984/4091) | As malnutrition worsened from mild to very severe, the risk of mortality, morbidity (results in paper), and hospital length of stay progressively increased |
| Novy <i>et al.</i> , 2021(28 0)   | Inclusion criteria: ≥75 years with severe acute cholangitis admitted to ICU<br><br>Exclusion criteria: NS                                                                                                                                                                               | 83 (79-89)              | 100.0 (180/ 180)               | <b>Albumin, BMI and weight loss</b><br>ICU patients (n = 85)<br>No malnutrition 21.2 (18/85)<br>Mild malnutrition 14.1 (12/85)<br>Severe malnutrition 65.7 (55/85)<br><br>General ward patients (n = 95)<br>No malnutrition 48.4 (46/95)<br>Mild malnutrition 18.9 (18/95)<br>Severe malnutrition 32.6 (31/95)                                                                                 | To describe the 6-month mortality in patients with severe acute cholangitis ≥75 years admitted to ICU (in comparison to the ward) and to identify factors associated with this mortality.                                    | ICU<br>In-hospital: 17.6 (15/85)<br>3-months: 38.8 (33/85)<br>6-months: 48.2 (41/85)<br><br>Ward<br>In-hospital: 15.8 (15/95)<br>3-months: 16.8 (16/95)<br>6-months: 30.5 (29/95)                                                                                                                                                                                                                      | Malnutrition was statistically associated with six month mortality in ICU and ward patients                                                                 |

Abbreviations: Body mass index (BMI); emergency general surgery (EGS); Geriatric Nutrition Risk Index (GNRI); Global Leadership Initiative on Malnutrition (mGLIM); intensive care unit (ICU); length of stay (LOS); National Surgical Quality Improvement Program (NSQIP); not stated (NS).

**Table S6:** A summary of a single centre study (not stated if retrospective or prospective)

| Author, year                      | Inclusion and exclusion criteria                                                                                                                                                                                                                                                                                                                                                                                            | Mean age, years (range) | EGS patients, % (n EGS/ total) | Measurement tool & malnourished EGS patients, % (n)                                                        | Study aim                                                                                                                                            | Primary outcome                                                                                                                                                                                          | Main nutrition outcome                                 |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| Khan, Ahmed and Safdar, 2016(265) | <p>Case-control study</p> <p>Inclusion criteria: aged 15-60 years with acute appendicitis, obstructive hernia, peritonitis of less than 2 days duration and blunt or penetrating soft tissue injuries; requiring surgical procedure within 12 hours of admission, ASA-1 and ASA-II</p> <p>Exclusion criteria: ASA ≥III, diabetes mellitus, chronic debilitation disease (chronic hepatitis B and C); immune-compromised</p> | NS (15-60)              | 100.0 (200/200)                | <p><b>BMI</b></p> <p>Nourished (BMI 18.50-24.99) 50 (100)</p> <p>Malnourished (BMI &lt;18.50) 50 (100)</p> | To determine the effects of pre-existing malnutrition on the overall outcome of surgery in emergency situation (chest infection and wound infection) | In malnourished patients, 27% had chest infections and 29% had wound infection (both significant). Whilst in nourished patients, 14% had chest infection and 18% had wound infections (not significant). | Preoperative malnutrition increases the morbidity rate |

Abbreviations: Body mass index (BMI); American Society of Anesthesiology (ASA); not stated (NS).

**Table S7:** Criteria used in defining malnutrition according to ‘core areas’

|                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Oral intake</b>                                                                                                                                                                                                                                                                                                                                                                              |
| <ul style="list-style-type: none"> <li>- Reduced oral intake (MST): intake past 1 week (3-Min NST, CNST); intake past 3 months (MNA SF, G8)</li> <li>- Dietary intake (SGA)</li> <li>- Number of daily meals (MNA)</li> <li>- Composition of meals (MNA)</li> <li>- Mode of feeding (MNA)</li> </ul>                                                                                            |
| <b>Appetite and weight loss</b>                                                                                                                                                                                                                                                                                                                                                                 |
| Any weight loss in past 6-months and a recent reduction in appetite (reported by patients)                                                                                                                                                                                                                                                                                                      |
| <b>Patient reported outcome</b>                                                                                                                                                                                                                                                                                                                                                                 |
| <ul style="list-style-type: none"> <li>- Health attitude (TEGS FI)</li> <li>- Self-assessment: in comparison to others of similar age (G8); do they think they have a nutritional problem (MNA)</li> </ul>                                                                                                                                                                                      |
| <b>Background</b>                                                                                                                                                                                                                                                                                                                                                                               |
| <ul style="list-style-type: none"> <li>- Age (G8)</li> <li>- Co-morbidities (TEGS FI)</li> <li>- Independent living (MNA)</li> <li>- Gastrointestinal symptoms (SGA)</li> <li>- Neuropsychological problems (G8, MNA SF, MNA)</li> <li>- Polypharmacy (G8, MNA)</li> <li>- Pressure ulcers (MNA)</li> </ul>                                                                                     |
| <b>Weight</b>                                                                                                                                                                                                                                                                                                                                                                                   |
| <ul style="list-style-type: none"> <li>- Weight loss (MST): in last 3-6 months (C-MUST); past 3 months (MNA); &gt;5% within the last 6 months or &gt;10% beyond 6 months (mGLIM)</li> <li>- Involuntary weight loss (MNA SF, G8)</li> <li>- Unintentional weight loss: past 6 months (3-Min NST); past 6 months (CNST)</li> <li>- Weight change (past 6 months + past 2 weeks) (SGA)</li> </ul> |
| <b>Body mass index</b>                                                                                                                                                                                                                                                                                                                                                                          |
| <p>Score points if:</p> <ul style="list-style-type: none"> <li>- &lt;18.5 one study and (C-MUST)</li> <li>- &lt;20 two studies and (3-Min NST)</li> <li>- ≤20 in patients aged ≤70 years and BMI ≤22 in patients aged &gt;70 (mGLIM)</li> <li>- &lt;23 (G8, MNA SF, MNA)</li> <li>- &lt;21 or ≥30 one study</li> <li>- &gt;35 one study</li> </ul>                                              |
| <b>Anthropometrics</b>                                                                                                                                                                                                                                                                                                                                                                          |
| <p>Loss of subcutaneous muscle (SGA)</p> <ul style="list-style-type: none"> <li>- Muscle wasting (3-Min NST, SGA)</li> <li>- Ankle oedema (SGA)</li> <li>- Sacral oedema or ascites (SGA)</li> <li>- Arm muscle circumference (AMC)</li> <li>- Mean arm circumference (MNA)</li> <li>- Calf circumference (MNA)</li> </ul>                                                                      |
| <b>Albumin</b>                                                                                                                                                                                                                                                                                                                                                                                  |
| - Albumin levels: <3.0g/dL (TEGS FI); ≤3.5g/dL (mGLIM)                                                                                                                                                                                                                                                                                                                                          |



|                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| - Admission levels, not stated<br>- Preoperative albumin: <3.0g/dL; Levels not stated                                                                                                                                                                 |
| <b>Miscellaneous</b>                                                                                                                                                                                                                                  |
| - CRP >10/L + albumin <3.5g/dL (mGPS)<br>- Cholinesterase levels <199U/L<br>- Haemoglobin, not stated<br>- Neutrophil to lymphocyte ratio, not stated<br>- Total number of lymphocytes, <1,200/ 1 mm <sup>3</sup>                                     |
| <b>Disease...</b>                                                                                                                                                                                                                                     |
| - <i>precluding</i> intake for >5 days (C-MUST)<br>- <i>with</i> nutrition risk (3-Min NST)<br>- <i>and</i> metabolic demand (SGA)<br>- <i>or</i> psychological stress in past 3 months (MNA SF, MNA)<br>- <i>represented</i> by EGS patients (mGLIM) |
| <b>Formulae</b>                                                                                                                                                                                                                                       |
| - <b>GNRI</b> (1.489 albumin [g/L]) + (41.7 [weight/ideal weight])<br>- <b>PNI</b> (%risk) = 158 – 16.6 (Alb) – 0.78 (TSF) – 0.20 (TFN) – 5.8 (DH)<br>- <b>NRI</b> (1.519 × serum albumin (g/L) + (0.417 × actual weight/ideal weight))               |
| <b>Function</b>                                                                                                                                                                                                                                       |
| - Handgrip strength<br>- Function (TEGS FI)<br>- Functional capacity (SGA)<br>- Mobility (MNA, MNA SF, G8)<br>- Daily activities (TEGS FI)                                                                                                            |
| <b>Albumin and weight loss</b>                                                                                                                                                                                                                        |
| Malnutrition if:<br>- Albumin <35g/L and weight loss in past 6 months<br>- Albumin <35 g/L and weight loss >5Kg during past few months                                                                                                                |
| <b>Albumin, BMI and weight loss</b>                                                                                                                                                                                                                   |
| Malnutrition if:<br>- BMI <21<br>- weight loss of 5% in 1 month or 10% in 6 months<br>- Albumin <35g/L                                                                                                                                                |
| <b>Albumin, BMI or weight loss</b>                                                                                                                                                                                                                    |
| Malnourished if:<br>- Albumin <30g/L<br>- weight loss ≥10%<br>- BMI <20.5                                                                                                                                                                             |
| <b>Albumin or BMI</b>                                                                                                                                                                                                                                 |
| Malnourished if:<br>- Albumin <3.5g/dL, BMI <18.5 or >24.9<br>- Albumin <3.8g/dL, BMI <18.5                                                                                                                                                           |

## Appendix 2

This section includes:

- Additional files to support Paper 2
  - **Additional File 1:** Research governance
  - **Additional File 2:** Ethical approval from University of Sheffield
  - **Additional File 3:** Email invitation
  - **Additional File 4:** Participant Information Sheet
  - **Additional File 5:** Methodology
  - **Additional File 6:** Final instrument
  - **Additional File 7:** Study user interface
- Supplementary tables for Paper 2
  - **Table S8:** Who performs malnutrition screening before, or after, emergency surgery?
  - **Table S9:** Reasons why screening or an assessment for malnutrition is not performed every time before or after surgery
  - **Table S10:** Screening or assessment methods routinely used to determine malnutrition risk
  - **Table S11:** Anthropometric methods routinely used to determine malnutrition risk
  - **Table S12:** Biochemical markers routinely used to determine malnutrition risk
  - **Table S13:** Body composition tests routinely used to determine malnutrition risk
  - **Table S14:** Functional tests routinely used to determine malnutrition risk
  - **Table S15:** Does your hospital have a surgical nutrition team/ Nutrition Support Team?
  - **Table S16:** Who performs a malnutrition assessment before, or after, emergency surgery?
  - **Table S17:** Reasons why a nutrition pathway does not exist pre- or post-operatively
  - **Table S18:** Local barriers in identifying malnutrition risk in NELA-eligible EGS patients
  - **Table S19:** Correlation of participant responses with laparotomy volume in their hospital
  - **Table S20:** Participants' responses relating to the frequency of screening and assessment for malnutrition pre- and post-operatively in hospitals with a NELA Lead for anaesthetics and surgery

- **Table S21:** Participants' responses relating to the presence of nutrition pathways pre- and post-operatively if a patient was at risk of malnutrition or malnourished in hospitals with a NELA Lead for anaesthetics and surgery
- **Table S22:** Distribution of participants' responses relating to perceptions regarding overall management of malnutrition risk in NELA-eligible patients in hospitals with a NELA Lead for anaesthetics and surgery
- **Table S23:** Association of participant response according to professional role for hospitals with a NELA Lead for anaesthetics and surgery
- **Table S24:** A summary of the free text comments regarding screening and assessment for malnutrition pre- and post-operatively

## **Additional files to support Paper 2**

### **Additional file 1: Research governance**

#### **Ethical approval**

This study was reviewed the University of Sheffield Medical School's Ethics Review Committee and approval was granted on 21<sup>st</sup> September 2022 (UREC 046205). NHS Research Ethics Committee approval was not required as the participants were NHS staff were recruited only by virtue of their profession.

#### **Informed consent**

Potential participants were emailed an invitation to read a Participant Information Sheet, which explained the identity of the researchers, contact details, the purpose for conducting the survey and how the data would be used. It also included information on how long it was estimated to complete, and who to contact if any issues arise. It was explicit that their involvement in the study was voluntary. Survey consent was implied by participants clicking on a link in the invitation email and proceeding to complete the survey by clicking on a second link on the welcome page. Participants were advised they can withdraw from the survey up until submission of their survey form.

#### **Confidentiality**

Survey responses were anonymous. Participants were offered to be kept informed regarding the findings of this study, any future studies relating to nutrition in emergency general surgery, or to avoid reminder emails to complete the survey by providing an email address at the end of the survey. It was explained that their email address would not be linked to their responses. Databases were password protected and stored as per the data management plan.

## Additional file 2: Ethical approval from University of Sheffield



Downloaded: 26/05/2024

Approved: 21/09/2022

Daniel Ashmore

Registration number: 210200731 Oncology

Programme: Postgraduate Research (PGR)

Dear Daniel

**PROJECT TITLE:** A Survey of NELA Leads to identify current nutrition practices and pathways in NELA-eligible EGS patients

**APPLICATION:** Reference Number 046205

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 21/09/2022 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 046205 (form submission date: 06/10/2022); (expected project end date: 01/12/2022).
- Participant information sheet 1105034 version 3 (01/09/2022).

The reviewers have left the following comments regarding the application:

Happy to approve the change from RedCap to QQ10 software. (And apologies for the delay - I have been out of the office) The following amendments to this application have been approved:

- Amendment approved: 03/10/2022

If during the course of the project you need to [deviate significantly from the above-approved documentation](#) please inform me since written approval will be required.

Your responsibilities in delivering this research project are set out at the end of this letter. Yours sincerely

Charlotte Cole

Ethics Admin

Medical School

Please note the following responsibilities of the researcher in delivering the research project:

- The project must abide by the University's Research Ethics Policy: <https://www.sheffield.ac.uk/research-services/ethics-integrity/policy> The project must abide by the University's Good Research & Innovation Practices Policy: [https://www.sheffield.ac.uk/polopoly\\_fs/1.671066!/file/GRIPPolicy.pdf](https://www.sheffield.ac.uk/polopoly_fs/1.671066!/file/GRIPPolicy.pdf)
- The researcher must inform their supervisor (in the case of a student) or Ethics Admin (in the case of a member of staff) of any significant changes to the project or the approved documentation.
- The researcher must comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
- The researcher is responsible for effectively managing the data collected both during and after the end of the project in line with best practice, and any relevant legislative, regulatory or contractual requirements.

## Additional file 3: Participant invitation email



**Re research study : 'Nutrition in Emergency General Surgery: A Survey of NELA Leads to identify current nutrition practices and pathways in NELA-eligible EGS patients'**

Dear NELA Lead [personalised email]

We are inviting you to participate in the above research study to investigate nutrition in emergency general surgery (EGS). In short, this survey will primarily aim to establish current practices, the use of nutrition decision tools and pathways, and potential organisational barriers in identifying malnutrition in NELA-eligible EGS patients in England and Wales. Pilot data suggests it will take you approximately **5 minutes** to complete the survey.

If you wish to take part, please click this link [https://shef.qualtrics.com/jfe/form/SV\\_cvUZNApYKqXDs4m](https://shef.qualtrics.com/jfe/form/SV_cvUZNApYKqXDs4m) to be directed to the survey.

This study is part of a set of wider research studies, and will contribute towards my PhD at the University of Sheffield.

As you will be aware, EGS provides complex management for patients admitted with an acute surgical pathology. However, identifying the most high risk patients in need of nutritional support can be difficult. Given malnutrition is a specific risk factor for mortality in EGS patients, this underlies the remit of this study.

Any publications from this study will maintain your confidentiality such that no-one can work out that you participated in the study.

Details and further information are contained within the Participant Information Sheet below.

**Thank you for considering taking part in the study.**

Kind regards

Mr Daniel Ashmore  
PhD student and Clinical Research Fellow  
University of Sheffield/ Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust,  
Email: [dlashmore1@sheffield.ac.uk](mailto:dlashmore1@sheffield.ac.uk)

Email invitation 1.1 dated 25/04/2022

## Additional file 4: Participant Information Sheet

### Participant Information Sheet

Dear NELA Lead

We are writing to you to invite you take participate in the above research study to investigate nutrition in emergency general surgery (EGS). This study is part of a wider research study, and will contribute towards my PhD at the University of Sheffield. If there is anything that is not clear, or if you would like more information, please ask us.

#### **1. What is the purpose of the study?**

This survey will primarily aim to establish current practices, the use of nutrition decision tools and pathways, and potential organisational barriers in identifying malnutrition in NELA-eligible EGS patients in England and Wales.

Emergency general surgery provides complex management for patients admitted with an acute surgical pathology. It is known that a subset of EGS patients are very high risk patients in the UK and worldwide. EGS patients also have an approximately eight times greater risk of mortality than elective admissions. Many EGS patients are often at risk of type I intestinal failure. Malnutrition is a specific risk factor for mortality in EGS patients, though often overlooked. The best method to identifying these at risk patients is not known. Despite malnutrition screening being commonplace within the UK, as recommended by the National Institute for Health and Care Excellence, this is not useful for identifying malnutrition within EGS patients and does not correlate with how long patients may require nutritional support. Guidance from European and American Societies offer less clarity for EGS patients.

#### **2. What will I have to do if I take part? Please take time to read and understand what the study will involve. You can speak to the research team who will answer any questions you may have.**

This study involves a survey of 16 questions and it will take you approximately five minutes to complete the survey. The survey is hosted by Qualtrics, an online platform approved by the University of Sheffield. You will be required to click a link to proceed to the survey and this will be considered as your consent to take part.

#### **3. What alternatives are there if I don't take part?**

If you decide not to take part in the study, then we will respect your wishes. There will be other studies we may approach you about in the future.

#### **4. What are the benefits of taking part?**

The information we collect from you and others will hopefully help improve the nutritional care for surgical patients in the future. You will therefore have assisted in this process.

#### **5. What are the disadvantages and risks associated with taking part in this study?**

Apart from your time involved in the study, there is no additional risk to your health from taking part in the study.

#### **6. Will I get paid for taking part?**



No, you will not receive any payment for taking part in this study.

**7. What will happen if I don't want to carry on with the study?**

You can stop taking part in the study at any point until submission of the survey, without giving any reason.

**8. What if there is a problem during the study?**

If you have any concerns or questions about this study, please contact Mr Daniel Ashmore, Clinical Research Fellow. Details can be found at the bottom of this information leaflet. If you have concerns about the way the survey was conducted or safeguarding concerns, please raise these by contacting Mr Matthew Lee or Dr Vanessa Halliday, supervisors of Mr Ashmore's PhD. Again, details can be found at the bottom of this leaflet.

**9. Will my taking part in this study be kept confidential?**

Yes. Your responses will be anonymous. You will be offered to be kept informed regarding the findings of this study, any future studies relating to nutrition in emergency general surgery, or to avoid reminder emails to complete the survey. If you provide your email address at the end of the survey then we will use your email address only for this purpose and it will not be passed on to any other party. Your email address will not be linked to your survey responses.

**10. What are the choices about how my information is used?**

You can stop taking part in the study at any point until submission of the survey, without giving any reason.

**11. What do you do with my information?**

The University of Sheffield is the Sponsor for this study. The study data will be stored securely and analysed at the University of Sheffield. The University of Sheffield will act as the data controller for this study. This means that the University of Sheffield is responsible for looking after your information and using it properly.

**12. What will happen to the results of the study?**

The results will be presented at conferences and published in peer-reviewed scientific journals. If a publication results from this research, it will be made available to you at the following academic website: <http://www.ncbi.nlm.nih.gov/pubmed/>. Under no circumstance will you be identified by name in any presentation or report.

**13. Who is organising and reviewing the study?**

This study has been reviewed by the University of Sheffield's Research Ethics Committee, who protect your safety, rights, wellbeing and dignity. The University of Sheffield has overall responsibility for the study. This study is unfunded.

**14. Who do I contact if I need further information?**

Mr Daniel Ashmore  
PhD student/ Clinical  
Research Fellow  
University of Sheffield  
Email:

[dlashmore1@sheffield.ac.uk](mailto:dlashmore1@sheffield.ac.uk)

Mr Matthew Lee  
Project Supervisor  
[m.j.lee@sheffield.ac.uk](mailto:m.j.lee@sheffield.ac.uk)

Dr Vanessa Halliday  
Project Supervisor  
[vanessa.halliday@sheffield.ac.uk](mailto:vanessa.halliday@sheffield.ac.uk)

**Thank you for reading this leaflet and considering taking part in the study.**

Patient Information Sheet Version 1.2 dated 04/07/2022

## Additional file 5: Methodology

### Survey development

#### Item generation

Potential items were generated with reference to current nutrition guidelines, the existing literature(43,98,109,112), the findings from Study 1 (systematic review) and expert opinion (the supervisory group). A guideline summary is provided (**Additional File Figure 1**). This expert panel consists of a registered dietitian, an academic surgeon and a colorectal surgeon with an interest in nutrition. All have experience with survey design. A summary of the domains is shown (**Additional File Table 1**).

**Additional File Table 1:** Domains identified through item generation

| Survey domains                                    | Theme                                               | Source derived                                            |
|---------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------------|
| <b>Participant demographics</b>                   | Sex, experience (years qualified), hospital setting | Literature                                                |
| <b>Screening and of assessment nutrition risk</b> | Identifying malnutrition (how, who's role)          | Systematic review, expert opinion, guidelines             |
|                                                   | Nutrition risk tools                                | Literature, systematic review, expert opinion, guidelines |
|                                                   | Risk assessment                                     | Literature, systematic review, expert opinion, guidelines |
|                                                   | Clinical decision making                            | Expert opinion                                            |
| <b>Process</b>                                    | Timing of first nutritional assessment              | Literature, systematic review, expert opinion, guidelines |
|                                                   | Timing of clinical decision making                  | Literature, expert opinion, guidelines                    |
| <b>Nutritional risk stratification</b>            | Process                                             | Literature, systematic review, expert opinion, guidelines |
|                                                   | Attitudes                                           | Expert opinion                                            |
| <b>Delivery of nutrition to EGS patients</b>      | Barriers to providing nutritional support           | Literature, expert opinion                                |
|                                                   | Nutrition support teams                             | Literature, expert opinion, guidelines                    |
|                                                   | Referral processes                                  | Literature, expert opinion                                |
|                                                   | Patient pre-op consent                              | Expert opinion                                            |

### **Screening and assessment of malnutrition risk**

NICE and ESPEN guidelines recommend nutritional screening on admission and throughout a patient's hospital stay; NICE advocate weekly screening for inpatients(98). ASPEN recommend screening within the first 48 hours of admission and a full assessment of patients admitted to ICU(109). All postoperative ICU patients should have their nutrition risk determined and it should not be based on visceral proteins(109).

ESPEN guidelines are typically aimed at elective patients on an ERAS protocol, rather than emergency. A nutrition assessment (not screening) is recommended pre- and post-op(112). Nutrition support is recommended in patients who will be unable to eat for >5 days postoperatively(43), or those who cannot maintain >50% recommended intake for >7 days. This is likely to be a substantial number of EGS patients.

### **Nutrition Support Teams**

NSTs are typically teams of dietitians, nurses, pharmacists and a doctor (gastroenterologist, surgeon, intensivist) aimed at optimising a patient's nutrition during their hospital stay(152–155). These are recommended by NICE(98) and ASPEN(109). ESPEN recommend NSTs for medical patients(156), but there are no guidelines for surgical patients. While there is high prevalence of these in the UK with approximately 80% of trusts having an NST(157), they are far less prevalent elsewhere based on a survey of ASPEN respondents(158).

### **Screening Tools**

- NICE: MUST(98)
- ESPEN: NRS-2002, MNA-SF and MUST; in critically ill patients they advise a general clinical assessment of nutrition should be performed until a specific tool has been validated, although every patient in ICU for more than 48 hours should be considered high risk for malnutrition(99).
- ASPEN: NRS 2002 and NUTRIC can be used in critically ill patients(109).
- GLIM: use a validated screening tool, and although none is recommended, the NRS 2002, MNA-SF, MUST and the SGA are presented as options.

### **Other methods to identify malnutrition**

- ESPEN, ASPEN and GLIM guidelines use a range of methods to assess malnutrition including muscle mass and functional status.

### **Use of pathways**

NICE recommend that patients identified as malnourished or at risk of malnutrition should be considered for nutritional support (oral, enteral, parenteral)(98). Almost all EGS patients undergoing major surgery such as an EL will therefore be classed as at risk of malnutrition and nutritional support ought to be offered. A recent systematic review has indicated that ERAS protocols are being tested in the EGS cohort, although the data is limited and more research is needed as to their effectiveness(42).

**Additional File Figure 1:** Guideline summary relevant for item generation

## Item selection

The domains and themes of interest were refined and those most relevant to the research question were selected (**Additional File Table 2**). The main three changes were:

1. Participant demographics focussed on role and hospital trust only. This would then allow correlation of responses with published NELA data and clinician role.
2. Perioperative nutrition screen and assessment separated. These are discrete stages of identifying malnourished patients and poorly reported in Study 1 (systematic review).
3. The delivery of nutrition domain was removed. It extends beyond identifying malnourished patients, varies considerably from hospital-to-hospital and capturing meaningful data would be difficult. Finally, it would lengthen the survey considerably and time to complete, likely reducing response rates.
- 4.

**Additional File Table 2:** Selection of survey domains

| Survey domains                               | Theme                                     | Reason for change                                                              |
|----------------------------------------------|-------------------------------------------|--------------------------------------------------------------------------------|
| <b>Participant demographics</b>              | Clinical role                             | To correlate responses to role                                                 |
|                                              | Hospital trust                            | To correlate responses to NELA data                                            |
| <b>Perioperative nutrition screening</b>     | Who completes it                          | Screening and assessment presented as separate entities in line with guidance. |
|                                              | Involvement of nutrition team             |                                                                                |
|                                              | Screening tools                           | Timing of screening and assessment made clear as pre-op versus post-op         |
|                                              | Timing (pre-/ post-op)                    |                                                                                |
| <b>Perioperative nutrition assessment</b>    | Who completes it                          | Clearer format, easier to understand, more focussed questions                  |
|                                              | Involvement of nutrition team             |                                                                                |
|                                              | Screening tools                           |                                                                                |
|                                              | Timing (pre-/ post-op)                    |                                                                                |
| <b>Management of patients at risk</b>        | Use of pathways                           | Replaces nutrition risk stratification                                         |
| <b>Attitudes and barriers</b>                | Barriers                                  | May inform future qual study                                                   |
| <b>Delivery of nutrition to EGS patients</b> | Barriers to providing nutritional support | Removed: beyond the scope of identifying malnutrition                          |
|                                              | Nutrition support teams                   | Incorporated in nutrition screening                                            |
|                                              | Referral processes                        | Removed: too individualised                                                    |
|                                              | Patient pre-op consent                    | Removed: beyond the scope of identifying malnutrition                          |

## **Operationalisation**

Through an iterative approach, question stems were kept shorter than 20 words using non-leading and unambiguous language, avoiding modifiers. It was evident from the systematic review that nutrition screening and nutrition assessment are separate processes and so the study was developed around assessing these as separate components. Directions to answer questions such as 'select one response' were given. Free text or 'other' responses were used for many questions, offering an opportunity to capture unanticipated responses. Likert scales were used and presented in a negative to positive direction, and an 'I do not know' option was also presented.

## **Survey formatting**

The survey format was kept simple in order to maximise response rate and reduce non-responder bias. Personalised e-mails were sent to potential participants with a maximum of three reminder emails. A progress bar was presented, as was the anticipated completion time in the participant information sheet and front page of the survey. The completion time was obtained from study testing, discussed below.

An adaptive format was used such that additional questions were only presented where certain responses were given to a previous question, as shown in the Final Instrument. This was to limit the burden of asking participants potentially irrelevant questions and allowed particular responses to be explored further where necessary.

## **Testing**

Each phase, including pre-testing, pilot testing and clinical sensibility testing, are discussed below.

### **Pre-testing**

This phase was achieved with input from the expert panel at the item selection and operationalisation stages of survey development.

### **Pilot testing**

The survey was distributed to ten general surgeons and ten anaesthetists that undertake EGS at Doncaster Royal Infirmary, a teaching hospital in the UK. Twelve participants completed the survey, but only eight

completed it and provided feedback (six general surgeons and two anaesthetists). This suggested a survey response rate of 60% may be achievable.

At first, the survey was developed in REDcap. It was subsequently changed to Qualtrics as some participants were finding it difficult to submit a completed survey on REDcap despite different internet browsers, settings and hardware. Both are University of Sheffield approved online survey development tools. This amendment had ethical approval.

### **Clinical sensibility testing/ acceptability**

At the same time as distributing the survey to general surgeons and anaesthetists that undertake EGS at Doncaster Royal Infirmary, face and content validity was assessed using a 'modified QQ-10'(303). The QQ-10 is a validated tool for use in healthcare settings(303) (**Additional File Figure 2**). It was modified slightly to account for this research being directed at participants who are healthcare professionals and not patients (**Additional File Figure 3**). Care and consideration were taken not to modify it to the extent that it was not representative of the original tool. In addition, feedback regarding question wording, survey structure and time taken to complete the survey were gathered. A summary of QQ-10 feedback for each of the ten statements (**Additional File Table 3**) and free text comments (**Additional File Table 4**) are provided.

Please circle the answers below each of the following 10 statements that best fit your feelings about the questionnaire that you recently completed.

Please use the boxes at the bottom of the next page to make additional comments

1. The questionnaire helped me to communicate about my condition  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
2. The questionnaire was relevant to my condition  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
3. The questionnaire was easy to complete  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
4. The questionnaire included all the aspects of my condition that I am concerned about  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
5. I enjoyed filling in the questionnaire  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
6. I would be happy to complete the questionnaire again in the future as part of my routine care  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
7. The questionnaire was too long  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
8. The questionnaire was too embarrassing  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
9. The questionnaire was too complicated  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
10. The questionnaire upset me  
Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree
11. Do you have any comments or suggestions on how the questionnaire you used could be improved (e.g. its structure, appearance or design)?
12. Were any of your important symptoms, problems or concerns missed out by the questionnaire you used?
13. Do you feel that any areas or problems in the questionnaire you used were over-represented?

**Additional File Figure 2:** Original QQ-10

Please circle the answers below each of the following 10 statements that best fit your feelings about the questionnaire that you recently completed.

Please use the boxes at the bottom of the next page to make additional comments.

1. The questionnaire helped me to communicate about **practices and pathways in NELA-eligible EGS patients**

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

2. The questionnaire was relevant to **practices and pathways in NELA-eligible EGS patients**

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

3. The questionnaire was easy to complete

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

4. The questionnaire included all the aspects of **practices and pathways in NELA-eligible EGS patients** that I am concerned about

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

5. I enjoyed filling in the questionnaire

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

6. I would be happy to complete the questionnaire again in the future as part of my routine care

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

7. The questionnaire was too long

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

8. The questionnaire was too embarrassing

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

9. The questionnaire was too complicated

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

10. The questionnaire upset me

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

11. Do you have any comments or suggestions on how the questionnaire you used could be improved (e.g. its structure, appearance or design)?

12. Were any of your **important problems or concerns** missed out by the questionnaire you used?

13. Do you feel that any areas or problems in the questionnaire you used were over-represented?

**14. How long did it take you to complete the questionnaire?**

**Additional File Figure 3:** Modified QQ-10

Changes to original QQ-10 highlighted in red.



**Additional File Table 3: QQ-10 results**

| Participant              | Strongly agree | Mostly agree | Neither agree or disagree | Mostly disagree | Strongly disagree |
|--------------------------|----------------|--------------|---------------------------|-----------------|-------------------|
| Q1, helped communicate   | 2              | 3            | 2                         | 1               |                   |
| Q2, relevant             | 3              | 4            |                           | 1               |                   |
| Q3, easy to complete     | 5              | 2            |                           | 1               |                   |
| Q4, included all aspects | 2              | 3            | 2                         | 1               |                   |
| Q5, enjoyed it           |                | 2            | 5                         | 1               |                   |
| Q6, happy to do again    | 1              | 5            | 1                         | 1               |                   |
| Q7, too long             | 1              |              | 2                         | 4               | 1                 |
| Q8, too embarrassing     |                |              |                           | 2               | 6                 |
| Q9, too complicated      |                | 1            | 1                         | 3               | 3                 |
| Q10, upsetting           |                |              |                           | 1               | 7                 |

Total responses = 8. Responses according to colour: general surgeons (black); one anaesthetist (green); second anaesthetist (red); same response from anaesthetists (blue).

Overall, the survey received positive feedback as indicated by the modified QQ-10 results. It confirmed was relevant, easy to complete and included all aspects pertinent to the practices and pathways in NELA-eligible patients. The majority of participants did not think it was too long, embarrassing, complicated or upsetting. There appeared to be disparity between the anaesthetists that completed the survey. The second anaesthetist appeared to select 'disagree' for almost all questions and this may represent survey fatigue. This could be expected if they had completed the survey as well as this additional feedback in the same sitting.

**Additional File Table 4:** Pilot study testing free text comments

| Participant        | Feedback received                                                                                                                                                                                                                                                                                                      | Remedial action                                                                                                                                                              |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1, General surgeon | 'Couldn't make it [REDCap] work.'                                                                                                                                                                                                                                                                                      | Changed to Qualtrics                                                                                                                                                         |
| 2, Anaesthetist    | <p>'I did try to complete it via the link a couple of weeks ago but when I submitted at the very end it didn't seem to work.'</p> <p>'From an anaesthetic perspective it seemed like a very long questionnaire for something we don't have a lot of input into – felt I was saying "I don't know" a lot of times!'</p> | <p>Changed to Qualtrics</p> <p>Given anaesthetic involvement in pre-op risk assessment with NELA patients, ongoing inclusion of anaesthetists were considered important.</p> |
| 3, General surgeon | 'The linked worked absolutely fine. Can't add anything more – you have thought through and designed it very well.'                                                                                                                                                                                                     | N/A                                                                                                                                                                          |
| 4, General surgeon | 'Didn't allow me to complete the survey 'on my server'.'                                                                                                                                                                                                                                                               | Changed to Qualtrics                                                                                                                                                         |
| 5, General surgeon | 'I have tried to compete the survey myself but the drop-down menus do not seem to work.'                                                                                                                                                                                                                               | No other feedback with the same issue. Participant was able to resubmit.                                                                                                     |
| 6, General surgeon | 'The link worked fine on a hospital computer. I am happy with the survey feedback. Not sure why you need question 8 – why would the survey be embarrassing?'                                                                                                                                                           | Irrelevant as QQ-10 will not be sent to participants for main study.                                                                                                         |
| 7, General surgeon | 'I found it quite difficult to work out the difference between screening for malnutrition risk and malnutrition status. Perhaps an explanation at the start for people like me who can't understand would help!'                                                                                                       | Definitions of screening and assessment including. Clarification of question wording and terminology                                                                         |
| 8, Anaesthetist    | No written feedback offered                                                                                                                                                                                                                                                                                            | N/A                                                                                                                                                                          |

The mean time for completion was six minutes (range 2-10 minutes). Free text comments confirmed appropriate question wording overall. Clearer definitions of screening and assessment were provided to ensure that participants answer the questions as they were intended to be asked. The following prefixed their respective sections of the survey:

- ***Perioperative Nutrition Screening***

This refers to a process of identifying patients that may have a malnutrition diagnosis and may benefit from an assessment by an appropriately registered healthcare professional.

- ***Perioperative Nutrition Assessment***

This is a systematic and comprehensive process of evaluating nutrition status by an appropriately registered healthcare practitioner. It would confirm a patient's nutrition risk, the likely underlying cause and develop a nutrition management plan.

The process of screening followed by a rigorous assessment may not be embedded within every hospital. Consequently, it was made clear that assessment of malnutrition was not dependent on screening for malnutrition having been performed prior, and vice versa.

## Reliability

Pilot study reliability was assessed as described (**Additional File Table 5**).

**Additional File Table 5:** Pilot study reliability

| Types of reliability                                                                         |                                                             | How assessed? | Description                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Test-retest reliability</b>                                                               | Not assessed                                                |               | Small number of participants in the pilot study.<br>Responses may change as respondents may review guidelines between repeat surveys<br>There may be concerns over participant anonymity.                                                                                                                                    |
| <b>Internal consistency<br/>Equivalent/<br/>parallel form<br/>Split-half<br/>reliability</b> | Not assessed                                                |               | Similar questions that were both positively and negatively framed were initially included but many were removed during the development of the survey to maintain a balance with burden and completion time.<br>Additional rewording questions would require generation of a significant question bank beyond study resources |
| <b>Inter-rater reliability</b>                                                               | Intra-class correlation of Likert scales in the pilot study |               | According to guidelines, the pilot study showed excellent reliability (mean ICC 0.995, 95% CI 0.889 – 0.989) using a mean-rating ( $k = 12$ ), consistency agreement, two-way random effects model(369).                                                                                                                     |

## Validity

Pilot study validity was assessed as described (**Additional File Table 6**).

**Additional File Table 6:** Pilot study validity

| Types of validity         | How assessed?                                                                                                                                                                                                                                        | Description                                    |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| <b>Face validity</b>      | Feedback using the validated QQ-10 tool and written feedback                                                                                                                                                                                         |                                                |
| <b>Content validity</b>   | As part of the QQ-10 feedback, 7/8 participants in the pilot study agreed the study included all relevant aspects of practices and pathways in NELA-eligible EGS patients, and there were no important problems or concerns missed out in the study. |                                                |
| <b>Criterion validity</b> | Not assessed                                                                                                                                                                                                                                         | No similar validated surveys identified.       |
| <b>Construct validity</b> | Not assessed                                                                                                                                                                                                                                         | Study included no abstract concepts to assess. |

## Administration

The study opened in October 2022 for ten weeks. There were no incentives offered. Responses were anonymous.

### Method of administration

There is a list of 'current' NELA Leads freely available at the time of the planned study(304). However, it is not known how contemporaneous it is, including whether they still currently work at the trust, fulfil the NELA Lead role or if their contact details are correct. Confirming these details will be achieved over email once initial contact has been made with an invitation email. As such, providing a link to complete the study (as with web-based studies) is administratively easier than alternative modes of survey distribution.

Additionally, it will save time and costs when resources are finite. Participant responses were gathered using Qualtrics survey software.

### **Response rates and sample size calculation**

There are 186 hospitals that submitted data to NELA's 7<sup>th</sup> report(13). Excluding hospitals that submitted fewer than 10 laparotomies per year to the database (n = 11) in keeping with NELA's updated outlier policy(305), there are potentially 175 eligible hospitals to be contacted. Each hospital is recommended to have an anaesthetic and a surgical NELA Lead (350 NELA Leads potentially), although for smaller hospitals this can be a role undertaken by one person. Assuming all 175 hospitals have two NELA Leads, 184 responses are required to achieve a 5% margin of error with a 95% confidence interval. As discussed earlier, web-based survey response rates can be as low as 35%, although the pilot study response rate was 60%. A return rate of 122-210 surveys is expected.

### **Reporting**

The results from the survey are reported with reference to the CHERRIES guidelines(199).

## Total Survey Error (TSE) and Total Survey Quality (TSQ)

There are a variety of sources of error in this study which focusses on a complex process (identifying malnutrition) in a complex setting (emergency general surgery). The potential sources of error in this study are wide ranging and are addressed using the TSE framework (**Additional File Table 7**).

**Additional File Table 7:** Strategies to address potential sources of error

| Domain                       | Subtheme                              | How addressed in this study                                                                                                                                                                                                                                             |
|------------------------------|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Respondent selection</b>  | Sampling error                        | Sample size is limited to a maximum of 300 NELA Leads, all of whom will be invited to complete the survey. Anaesthetists may consider the survey to be less relevant to their role as identified in the pilot study, so this will be explained in the invitation email. |
|                              | Coverage error                        | List of hospitals obtained from NELA 7 <sup>th</sup> report with wide geographic coverage.                                                                                                                                                                              |
|                              | Non-response at unit level            | Reminder emails distributed for non-responders.                                                                                                                                                                                                                         |
| <b>Response accuracy</b>     | Non-response at item level            | Anonymity, clear instructions for participants, and mandated answers for selected questions. Mean completion time of 6 minutes limits participant burden.                                                                                                               |
|                              | Measurement error due to participants | Anonymity to encourage responses which differ from practice norms. Mean completion time of 6 minutes limits participant burden.                                                                                                                                         |
|                              | Measurement error due to interviewers | Not applicable as web-based survey.                                                                                                                                                                                                                                     |
| <b>Survey administration</b> | Post-survey error                     | Data management plan in situ.                                                                                                                                                                                                                                           |
|                              | Mode effects                          | Web-based survey known to have reduced response rates. Reminder emails will be distributed as necessary.                                                                                                                                                                |
|                              | Comparison error                      | No comparisons planned.                                                                                                                                                                                                                                                 |

## Additional file 6: Final instrument

The final instrument was created incorporating feedback from the testing stage of the survey development. There were five sections, headed by an introduction and thanks, and closed by an ending and email request. The background section asks just two questions. These are what their current role is and which hospital trust they work in. The subsequent sections include questions related to the current practice from a trust perspective regarding screening, assessment and management of perioperative nutrition in EGS patients. The final section explores organisational difficulties that may be encountered and whether collecting data on malnutrition would be beneficial for laparotomy patients.

- Introduction and thanks
- Background
- Emergency Surgery Perioperative Nutrition Screening
- Emergency Surgery Perioperative Nutrition Assessment
- Management of Patients Identified at Risk of Malnutrition or Malnourished
- Nutrition and NELA-eligible EGS patients: organisational difficulties
- End and email request

Questions were from a drop-down list, a 5-point Likert with a 'don't know' option, or a selection of options from a menu. Instructions to 'select one' or 'select all that apply' were given as appropriate. Questions were adaptively formatted to understand why an event happens or does not happen, with free text boxes also offered. There were up to 5 questions per page displayed on 17 pages including the opening and closure pages; a progress bar was visible. Mandatory questions were indicated and participants were able to review answers.

The full and final survey can be seen below, as can the user-interface seen by participants on a computer and a tablet/ phone (**Additional File Figure 4** and **Additional File Figure 5**). The blue boxes contain adaptive formatting instructions.



## **Introduction and thanks**

Start of Block: Intro and thanks

Q1 Thank you for taking part in this study.

It takes approximately 5 minutes to complete.

When answering the questions in this survey, please only focus on NELA-eligible emergency general surgical (EGS) patients with reference to your usual NHS place of work.

End of Block: Intro and thanks

---

Start of Block: Background

Q2 **Background**

-----

Q3 What is your main current clinical role, beside NELA Lead?

- ☐ Anaesthetist (1)
  - ☐ General surgeon (2)
  - ☐ Intensive care physician (3)
  - ☐ Other\_\_\_\_\_ (4)
- 

Display This Question:

*If What is your main current clinical role, beside NELA Lead? = Other\_\_\_\_\_*

Q4 If you selected 'other', please type your answer into the box here

---

---

---

-----

Page Break

Q5 Which hospital(s) are you the NELA-Lead for? (drop down menu)

- Addenbrookes Hospital (1)
- Aintree University Hospital (2)
- Airedale General Hospital (3)
- Arrowe Park Hospital (4)
- Barnet Hospital (5)
- Barnsley Hospital (6)
- Basildon University Hospital (7)
- Basingstoke and North Hampshire Hospital (8)
- Bedford Hospital (9)
- Birmingham Heartlands Hospital (10)
- Blackpool Victoria Hospital (11)
- Bradford Royal Infirmary (12)
- Bristol Royal Infirmary (13)
- Bronglais General Hospital (14)
- Broomfield Hospital (15)
- Castle Hill Hospital (16)
- Charing Cross (17)
- Chelsea and Westminster Hospital (18)
- Cheltenham Hospital (19)
- Chesterfield Royal Hospital (20)
- Churchill Hospital (21)
- City Hospital (22)
- Colchester General Hospital (23)
- Conquest Hospital (24)
- Countess of Chester Hospital (25)
- Croydon University Hospital (26)
- Cumberland Infirmary (27)
- Darent Valley Hospital (28)
- Darlington Memorial Hospital (29)
- Derriford Hospital (30)
- Dewsbury and District Hospital (31)
- Diana Princess of Wales Hospital (32)
- Doncaster Royal Infirmary (33)
- Dorset County Hospital (34)
- Ealing Hospital (35)
- East Surrey Hospital (36)
- Freeman Hospital (37)
- Frimley Park Hospital (38)
- Furness General Hospital (39)
- George Eliot Hospital (40)
- Glan Clwyd Hospital (41)
- Glangwili General Hospital (42)
- Gloucestershire Royal Hospital (43)
- Good Hope Hospital (44)
- Grange University Hospital (45)
- Harefield Hospital (46)
- Harrogate District Hospital (47)
- Hereford County Hospital (48)
- Hillingdon Hospital (49)
- Hinchingsbrooke Hospital (50)
- Homerton Hospital (51)
- Huddersfield Royal Infirmary (52)
- Hull Royal Infirmary (53)
- Ipswich Hospital (54)
- James Paget University Hospital (55)
- John Radcliffe Hospital (56)
- Kent and Canterbury Hospital (57)
- Kettering General Hospital (58)
- King George Hospital (59)
- King's College Hospital (60)
- Kings Mill Hospital (61)
- Kingston Hospital (62)
- Leicester General Hospital (63)
- Leicester Royal Infirmary (64)
- Leighton Hospital (65)
- Lincoln County Hospital (66)
- Lister Hospital (67)
- Luton and Dunstable Hospital (68)
- Macclesfield District General Hospital (69)
- Maidstone Hospital (70)
- Manchester Royal Infirmary (71)
- Medway Maritime Hospital (72)
- Milton Keynes Hospital (73)
- Morriston Hospital (74)
- Musgrove Park Hospital (75)
- Nevill Hall Hospital (76)
- New Cross Hospital (77)
- Newham University Hospital (78)
- Noble's Hospital (79)
- Norfolk and Norwich University Hospital (80)
- North Devon District Hospital (81)
- North Manchester General Hospital (82)
- North Middlesex University Hospital (83)
- Northampton General Hospital (84)
- Northern General Hospital (85)
- Northumbria Specialist Emergency Care Hospital (86)
- Northwick Park/St Marks Hospital (87)
- Nottingham City Hospital (88)
- Peterborough City Hospital (89)
- Pilgrim Hospital (90)
- Pinderfields Hospital (91)
- Poole Hospital (92)
- Prince Charles Hospital (93)
- Princess Alexandra Hospital (94)
- Princess of Wales Hospital (95)
- Queen Alexandra Hospital (96)
- Queen Elizabeth Hospital - Gateshead (97)
- Queen Elizabeth Hospital (Lewisham and Greenwich NHS Trust) (98)

- Queen Elizabeth Hospital Birmingham (99)
- Queen Elizabeth The Queen Mother Hospital (100)
- Queen's Hospital - Burton (101)
- Queen's Hospital - Romford (102)
- Queens Medical Centre - Nottingham (103)
- Rotherham Hospital (104)
- Royal Albert Edward Infirmary (105)
- Royal Berkshire Hospital (106)
- Royal Blackburn Hospital (107)
- Royal Bolton Hospital (108)
- Royal Cornwall Hospital (109)
- Royal Derby Hospital (110)
- Royal Devon and Exeter Hospital (111)
- Royal Free Hospital (112)
- Royal Glamorgan (113)
- Royal Gwent Hospital (114)
- Royal Hampshire County Hospital (115)
- Royal Lancaster Infirmary (116)
- Royal Liverpool University Hospital (117)
- Royal Marsden Hospital (118)
- Royal Preston Hospital (119)
- Royal Shrewsbury Hospital (120)
- Royal Stoke University Hospital (121)
- Royal Surrey County Hospital (122)
- Royal Sussex County Hospital (123)
- Royal United Hospital (124)
- Royal Victoria Infirmary (125)
- Russells Hall Hospital (126)
- Salford Royal Hospital (127)
- Salisbury District Hospital (128)
- Sandwell General Hospital (129)
- Scarborough Hospital (130)
- Scunthorpe General Hospital (131)
- South Tyneside District Hospital (132)
- Southampton General Hospital (133)
- Southend University Hospital (134)
- Southmead Hospital (135)
- Southport District General Hospital (136)
- St George's Hospital (137)
- St Helier Hospital (138)
- St James's University Hospital (139)
- St Mary's Hospital (140)
- St Mary's Hospital - Isle of Wight (141)
- St Peter's Hospital (142)
- St Richards Hospital (143)
- St Thomas' Hospital (144)
- Stepping Hill Hospital (145)
- Stoke Mandeville Hospital (146)
- Sunderland Royal Hospital (147)
- Tameside General Hospital (148)
- The Christie (149)
- The Great Western Hospital (150)
- The James Cook University Hospital (151)
- The Princess Royal Hospital (152)
- The Princess Royal University Hospital (153)
- The Queen Elizabeth Hospital - King's Lynn (154)
- The Royal Bournemouth Hospital (155)
- The Royal London Hospital (156)
- The Royal Oldham Hospital (157)
- Torbay District General Hospital (158)
- Tunbridge Wells Hospital (159)
- University College Hospital (160)
- University Hospital Lewisham (161)
- University Hospital Llandough (162)
- University Hospital North Durham (163)
- University Hospital of North Tees (164)
- University Hospital of Wales (165)
- University Hospital, Coventry (166)
- Walsall Manor Hospital (167)
- Warrington Hospital (168)
- Warwick Hospital (169)
- Watford General Hospital (170)
- West Middlesex University Hospital (171)
- West Suffolk Hospital (172)
- Weston General Hospital (173)
- Wexham Park Hospital (174)
- Whipps Cross University Hospital (175)
- Whiston Hospital (176)
- Whittington Hospital (177)
- William Harvey Hospital (178)
- Withybush General Hospital (179)
- Worcestershire Royal Hospital (180)
- Worthing Hospital (181)
- Wrexham Maelor Hospital (182)
- Wythenshawe Hospital (183)
- Yeovil District Hospital (184)
- York Hospital (185)
- Ysbyty Gwynedd Hospital (186)

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End of Block: Background

Start of Block: Screening for malnutrition - before surgery

Q6 **Emergency Surgery Perioperative Nutrition Screening**

For the purposes of this section, 'nutrition screening' refers to a process of identifying patients that may have a malnutrition diagnosis, and may benefit from an assessment by an appropriately registered healthcare professional.

Q7 How often is screening for malnutrition risk performed **prior to** emergency surgery? (please select one response)

- ☐ Never (1)
- ☐ Rarely (2)
- ☐ Occasionally (3)
- ☐ Regularly (4)
- ☐ All the time (5)
- ☐ Don't know (6)

Display This Question:

If How often is screening for malnutrition risk performed prior to emergency surgery? (please select... = Rarely  
Or How often is screening for malnutrition risk performed prior to emergency surgery? (please select... =  
Occasionally  
Or How often is screening for malnutrition risk performed prior to emergency surgery? (please select... =  
Regularly  
Or How often is screening for malnutrition risk performed prior to emergency surgery? (please select... = All  
the time

Q8 Who is it performed by? (please select all that apply)

- ☐ Dietitian (1)
- ☐ Nutrition support team (NST) (2)
- ☐ General surgeons (3)
- ☐ Intensive care team (4)
- ☐ Geriatrician (5)
- ☐ Anaesthetists (6)
- ☐ Nurses (7)
- ☐ Healthcare assistants (8)
- ☐ I do not know (9)
- ☐ Other\_\_\_\_\_ (10)

Display This Question:

If Who is it performed by? (please select all that apply) = Other\_\_\_\_\_

Q9 If you selected 'other', please type your answer into the box here

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*Display This Question:*

*If How often is screening for malnutrition risk performed prior to emergency surgery? (please select... = Never*  
*Or How often is screening for malnutrition risk performed prior to emergency surgery? (please select... =*  
*Rarely*  
*Or How often is screening for malnutrition risk performed prior to emergency surgery? (please select... =*  
*Occasionally*  
*Or How often is screening for malnutrition risk performed prior to emergency surgery? (please select... =*  
*Regularly*

Q10 Why is it not performed all the time? (please select all that apply)

- ☐ Lack of access to appropriate person to screen for malnutrition (1)
  - ☐ No time to screen for malnutrition prior to emergency surgery (2)
  - ☐ Would not change immediate management (3)
  - ☐ Lack of appropriate training (4)
  - ☐ I do not know (5)
  - ☐ Other (6)
- 

*Display This Question:*

*If Why is it not performed all the time? (please select all that apply) = Other*

Q11 If you selected 'other', please type your answer into the box here

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End of Block: Screening for malnutrition - before surgery

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Start of Block: Screening for malnutrition - after surgery

Q12 How often is screening for malnutrition risk performed **after** emergency surgery? (please select one response)

- ☐ Never (1)
- ☐ Rarely (2)
- ☐ Occasionally (3)
- ☐ Regularly (4)
- ☐ All the time (5)
- ☐ Don't know (6)

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*Display This Question:*

*If How often is screening for malnutrition risk performed after emergency surgery? (please select on... = Rarely*

*Or How often is screening for malnutrition risk performed after emergency surgery? (please select on... =*

*Occasionally*

*Or How often is screening for malnutrition risk performed after emergency surgery? (please select on... =*

*Regularly*

*Or How often is screening for malnutrition risk performed after emergency surgery? (please select on... = All the time*

Q13 Who is it performed by? (please select all that apply)

- ☐ Dietitian (1)
- ☐ Nutrition support team (NST) (2)
- ☐ General surgeons (3)
- ☐ Intensive care team (4)
- ☐ Geriatrician (5)
- ☐ Anaesthetists (6)
- ☐ Nurses (7)
- ☐ Healthcare assistants (8)
- ☐ I do not know (9)
- ☐ Other\_\_\_\_\_ (10)

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*Display This Question:*

*If Who is it performed by? (please select all that apply) = Other\_\_\_\_\_*

Q14 If you selected 'other', please type your answer into the box here

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*Display This Question:*

*If How often is screening for malnutrition risk performed after emergency surgery? (please select on... = Never*

*Or How often is screening for malnutrition risk performed after emergency surgery? (please select on... = Rarely*

*Or How often is screening for malnutrition risk performed after emergency surgery? (please select on... = Occasionally*

*Or How often is screening for malnutrition risk performed after emergency surgery? (please select on... = Regularly*

Q15 Why is it not performed all the time? (please select all that apply)

- ☐ Lack of access to appropriate person to screen for malnutrition (1)
- ☐ No time to screen for malnutrition after emergency surgery (2)
- ☐ Would not change immediate management (3)
- ☐ Lack of appropriate training (4)
- ☐ I do not know (5)
- ☐ Other (6)

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*Display This Question:*

*If Why is it not performed all the time? (please select all that apply) = Other*

Q16 If you selected 'other', please type your answer into the box here

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End of Block: Screening for malnutrition - after surgery

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Start of Block: NST

Q28 Does your hospital have a surgical nutrition team/ Nutrition Support Team?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I do not know (3)

End of Block: NST

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Start of Block: Screening tools/ assessment methods

Q29 Which malnutrition screening tools are used in your hospital? (please select all that apply)

- ☐ Mini Nutritional Assessment-Short Form (MNA-SF) (1)
- ☐ Malnutrition Screening Tool (MST) (2)
- ☐ Malnutrition Universal Screening Tool (MUST) (3)
- ☐ Nutrition Risk Score-2002 (NRS-2002) (4)
- ☐ Nutrition Risk Index (NRI) (5)
- ☐ Weight, Appetite, Ability to eat, Stress factor, Pressure ulcer/wound (WAASP) (6)
- ☐ Short Nutritional Assessment Questionnaire (SNAQ) (7)
- ☐ Subjective Global Assessment (SGA) (8)
- ☐ Nutrition Risk in Critically ill (NUTRIC) (9)
- ☐ None (10)
- ☐ I do not know (11)
- ☐ Other \_\_\_\_\_ (12)

*Display This Question:*

*If Which malnutrition screening tools are used in your hospital? (please select all that apply) = Other*

Q30 If you selected 'other', please type your answer into the box here

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Q31 Which of the following methods/ tests are routinely used to determine malnutrition risk prior to emergency general surgery? (please select all that apply)

**Anthropometric**

- ☐ Weight history (percentage weight loss over a fixed period of time) (1)
- ☐ Body mass index (BMI) (2)
- ☐ Mid-upper arm circumference (3)
- ☐ Skin fold thickness (eg triceps) (4)
- ☐ None (5)
- ☐ I do not know (6)
- ☐ Other \_\_\_\_\_ (7)



*Display This Question:*

*If Which of the following methods/ tests are routinely used to determine malnutrition risk prior to... = Other*

Q32 If you selected 'other', please type your answer into the box here

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Q33 Which of the following methods/ tests are routinely used to determine malnutrition risk prior to emergency general surgery? (please select all that apply)

**Biochemical markers**

- ☐ Albumin (1)
- ☐ Pre-albumin (2)
- ☐ Total protein (3)
- ☐ C-reactive protein (CRP) (4)
- ☐ Transferrin (5)
- ☐ None (6)
- ☐ I do not know (7)
- ☐ Other \_\_\_\_\_ (8)

*Display This Question:*

*If Which of the following methods/ tests are routinely used to determine malnutrition risk prior to... = Other*

Q34 If you selected 'other', please type your answer into the box here

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Q35 Which of the following methods/ tests are routinely used to determine malnutrition risk prior to emergency general surgery? (please select all that apply)

### **Body composition**

- ☐ Bioelectrical impedance analysis (1)
- ☐ Computerised tomography (CT) scan (eg skeletal muscle index, psoas muscle density) (2)
- ☐ Bone density scan (DEXA) (3)
- ☐ None (4)
- ☐ I do not know (5)
- ☐ Other \_\_\_\_\_ (6)

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*Display This Question:*

*If Which of the following methods/ tests are routinely used to determine malnutrition risk prior to... = Other*

Q36 If you selected 'other', please type your answer into the box here

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Q37 Which of the following methods/ tests are routinely used to determine malnutrition risk prior to emergency general surgery? (please select all that apply)

### **Functional tests**

- ☐ Self-reported physical function questionnaire (1)
- ☐ Hand grip strength (2)
- ☐ Timed get-up-and-go (3)
- ☐ Stair climb (4)
- ☐ Gait speed (5)
- ☐ None (6)
- ☐ I do not know (7)
- ☐ Other \_\_\_\_\_ (8)

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*Display This Question:*

*If Which of the following methods/ tests are routinely used to determine malnutrition risk prior to... = Other*

Q38 If you selected 'other', please type your answer into the box here

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End of Block: Screening tools/ assessment methods

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Start of Block: Emergency Surgery Perioperative Nutrition Assessment - before surgery

Q17 **Emergency Surgery Perioperative Nutrition Assessment**

For the purposes of this section, 'nutrition assessment' refers to a systematic and comprehensive process of evaluating nutrition status by an appropriately registered healthcare practitioner. It will confirm a patient's nutrition risk, the likely underlying cause and develop a nutrition management plan.

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Q18 How often is an assessment for malnutrition performed **prior to** emergency surgery? (regardless of whether or not they were screened for malnutrition) (please select one response)

- ☐ Never (1)
  - ☐ Rarely (2)
  - ☐ Occasionally (3)
  - ☐ Regularly (4)
  - ☐ All the time (5)
  - ☐ Don't know (6)
- 

*Display This Question:*

*If How often is an assessment for malnutrition performed prior to emergency surgery? (regardless of... = Rarely*

*Or How often is an assessment for malnutrition performed prior to emergency surgery? (regardless of... = Occasionally*

*Or How often is an assessment for malnutrition performed prior to emergency surgery? (regardless of... = Regularly*

*Or How often is an assessment for malnutrition performed prior to emergency surgery? (regardless of... = All the time*

Q19 Who is it performed by? (please select all that apply)

- ☐ Dietitian (1)
  - ☐ Nutrition support team (NST) (2)
  - ☐ General surgical team (3)
  - ☐ Intensive care team (4)
  - ☐ Geriatrician (5)
  - ☐ Anaesthetists (6)
  - ☐ Nurses (7)
  - ☐ Healthcare assistants (8)
  - ☐ I do not know (9)
  - ☐ Other\_\_\_\_\_ (10)
- 

*Display This Question:*

*If Who is it performed by? (please select all that apply) = Other\_\_\_\_\_*

Q20 If you selected 'other', please type your answer into the box here

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*Display This Question:*

*If How often is an assessment for malnutrition performed prior to emergency surgery? (regardless of... = Never  
Or How often is an assessment for malnutrition performed prior to emergency surgery? (regardless of... =  
Rarely  
Or How often is an assessment for malnutrition performed prior to emergency surgery? (regardless of... =  
Occasionally  
Or How often is an assessment for malnutrition performed prior to emergency surgery? (regardless of... =  
Regularly*

Q21 Why is it not performed all the time? (please select all that apply)

- ☐ Lack of access to appropriate person to perform a malnutrition assessment (1)
- ☐ No time for an assessment prior to emergency surgery (2)
- ☐ Would not change immediate management (3)
- ☐ Lack of appropriate training (4)
- ☐ I do not know (5)
- ☐ Other (6)

*Display This Question:*

*If Why is it not performed all the time? (please select all that apply) = Other*

Q22 If you selected 'other', please type your answer into the box here

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End of Block: Emergency Surgery Perioperative Nutrition Assessment - before surgery

Start of Block: Emergency Surgery Perioperative Nutrition Assessment - after surgery

Q23 How often is an assessment for malnutrition performed **after** emergency surgery (regardless of whether or not they were screened for malnutrition)? (please select one response)

- ☐ Never (1)
- ☐ Rarely (2)
- ☐ Occasionally (3)
- ☐ Regularly (4)
- ☐ All the time (5)
- ☐ Don't know (6)

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Display This Question:

If How often is an assessment for malnutrition performed after emergency surgery (regardless of whet... = Rarely

Or How often is an assessment for malnutrition performed after emergency surgery (regardless of whet... = Occasionally

Or How often is an assessment for malnutrition performed after emergency surgery (regardless of whet... = Regularly

Or How often is an assessment for malnutrition performed after emergency surgery (regardless of whet... = All the time

Q24 Who is it performed by? (please select all that apply)

- ☐ Dietitian (1)
- ☐ Nutrition support team (NST) (2)
- ☐ General surgeons (3)
- ☐ Intensive care team (4)
- ☐ Geriatrician (5)
- ☐ Anaesthetists (6)
- ☐ Nurses (7)
- ☐ Healthcare assistants (8)
- ☐ I do not know (9)
- ☐ Other\_\_\_\_\_ (10)

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Display This Question:

If Who is it performed by? (please select all that apply) = Other\_\_\_\_\_

Q25 If you selected 'other', please type your answer into the box here

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*Display This Question:*

*If How often is an assessment for malnutrition performed after emergency surgery (regardless of whet... = Never*

*Or How often is an assessment for malnutrition performed after emergency surgery (regardless of whet... = Rarely*

*Or How often is an assessment for malnutrition performed after emergency surgery (regardless of whet... = Occasionally*

*Or How often is an assessment for malnutrition performed after emergency surgery (regardless of whet... = Regularly*

Q26 Why is it not performed all the time? (please select all that apply)

- ☐ Lack of access to appropriate person to perform a malnutrition assessment (1)
- ☐ No time for an assessment after emergency surgery (2)
- ☐ Would not change immediate management (3)
- ☐ Lack of appropriate training (4)
- ☐ I do not know (5)
- ☐ Other (6)

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*Display This Question:*

*If Why is it not performed all the time? (please select all that apply) = Other*

Q27 If you selected 'other', please type your answer into the box here

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End of Block: Emergency Surgery Perioperative Nutrition Assessment - after surgery

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## Start of Block: Management of Patients Identified at Risk of Malnutrition or Malnourished

### **Management of Patients Identified at Risk of Malnutrition or Malnourished**

Q39 Following screening and/ or an assessment of malnutrition, if a patient is identified as at risk of malnutrition or malnourished, does a pathway or protocol exist to provide nutritional support **pre-operatively** in your hospital?

- ☐ Yes (1)
- ☐ No (2)

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*Display This Question:*

*If Following screening and/ or an assessment of malnutrition, if a patient is identified as at risk... = No*

Q40 If no, then why is this? (please select all that apply)

- ☐ Insufficient time to implement nutritional support for emergency patients pre-operatively (1)
- ☐ Implementing nutritional support for emergency patients pre-operatively would not improve patient outcomes (reduce complications or mortality) (2)
- ☐ Inadequate resources to implement nutritional support (3)
- ☐ I do not know (4)
- ☐ Other\_\_\_\_\_ (5)

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*Display This Question:*

*If If no, then why is this? (please select all that apply) = Other\_\_\_\_\_*

Q41 If you selected 'other', please type your answer into the box here

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Q42 Following screening and/ or an assessment of malnutrition, if a patient is identified as at risk of malnutrition or malnourished, does a pathway or protocol exist to provide nutritional support **post-operatively** in your hospital?

- ☐ Yes (1)
- ☐ No (2)

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*Display This Question:*

*If Following screening and/ or an assessment of malnutrition, if a patient is identified as at risk... = No*



Q43 If no, then why is this? (please select all that apply)

- ☐ Insufficient time to implement nutritional support for emergency patients post-operatively (1)
- ☐ Implementing nutritional support for emergency patients post-operatively would not improve patient outcomes (reduce complications or mortality) (2)
- ☐ Inadequate resources to implement nutritional support (3)
- ☐ I do not know (4)
- ☐ Other\_\_\_\_\_ (5)

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*Display This Question:*

*If If no, then why is this? (please select all that apply) = Other\_\_\_\_\_*

Q44 If you selected 'other', please type your answer into the box here

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End of Block: Management of Patients Identified at Risk of Malnutrition or Malnourished

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Start of Block: Nutrition and NELA-eligible EGS patients: organisational difficulties

**Nutrition and NELA-eligible EGS patients: organisational difficulties**

Q45 Please indicate the extent to which you agree or disagree with the following statements.

|                                                                                                                       | Strongly disagree (1) | Disagree (2)          | Neither agree nor disagree (3) | Agree (4)             | Strongly agree (5)    |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|--------------------------------|-----------------------|-----------------------|
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients pre-operatively. (1)       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> |
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients postoperatively. (2)       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> |
| I am confident that my team is able to identify and manage emergency general surgical patients with malnutrition. (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Please indicate the extent to which you agree or disagree with the following statements. = Strongly disagree  
Or Please indicate the extent to which you agree or disagree with the following statements. = Disagree

Q46 Please tell us what the local difficulties or barriers are in identifying malnutrition risk in NELA-eligible EGS patients. (please select all that apply)

- ☐ Acceptability of a malnutrition screening and/or assessment process (1)
- ☐ Clinical judgement is viewed as better than using a screening tool (2)
- ☐ Lack of organisational support (3)
- ☐ Lack of training and education (4)
- ☐ Lack of working relationship with dietetic team (5)
- ☐ Lack of evidence that adequate nutritional support improves outcomes in EGS (6)
- ☐ Lack of time to in the emergency setting (7)
- ☐ Unclear who is responsible for managing perioperative malnutrition (8)
- ☐ Other\_\_\_\_\_ (9)

Display This Question:

If Please tell us what the local difficulties or barriers are in identifying malnutrition risk in NE... =  
Other\_\_\_\_\_

Q47 If you selected 'other', please type your answer into the box here

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Q48 Please indicate the extent to which you agree or disagree with the following statements.

|                                                                                                                                                                 | Strongly<br>disagree<br>(1) | Disagree<br>(2)       | Neither<br>agree nor<br>disagree (3) | Agree<br>(4)          | Strongly<br>agree (5) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------|--------------------------------------|-----------------------|-----------------------|
| It would be beneficial to have a standard protocol or pathway for identifying and managing perioperative malnutrition as it might improve patient outcomes. (1) | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/>                | <input type="radio"/> | <input type="radio"/> |
| It would be beneficial to include malnutrition risk as part of the NELA data collection process. (2)                                                            | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/>                | <input type="radio"/> | <input type="radio"/> |

End of Block: Nutrition and NELA-eligible EGS patients: organisational difficulties

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Start of Block: Email request

**End and email request**

Q49 If you would like to be kept informed regarding the findings of this study, any future studies relating to nutrition in emergency general surgery, or to avoid reminder emails to complete the above survey, please enter your email address below.

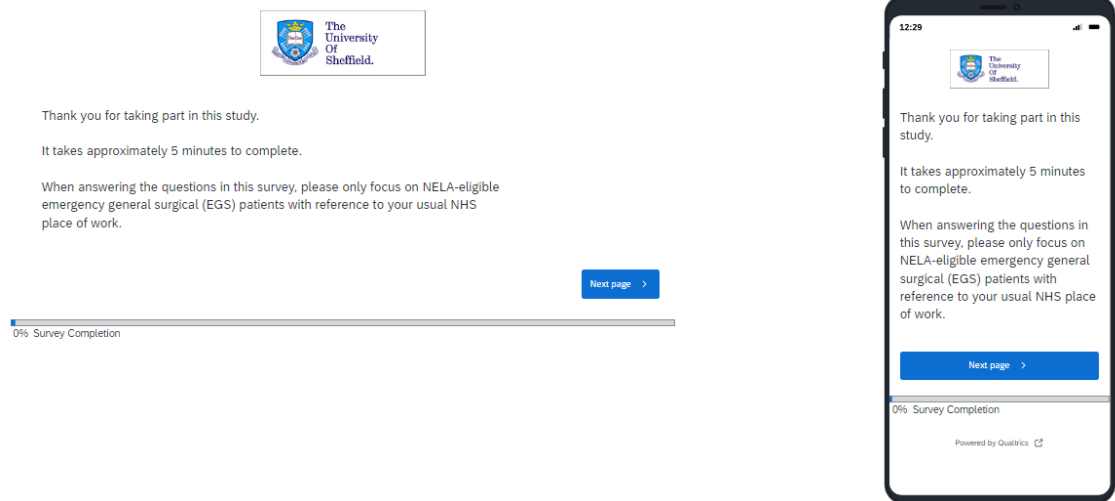
Your email address will NOT be linked to any of your answers in this study.

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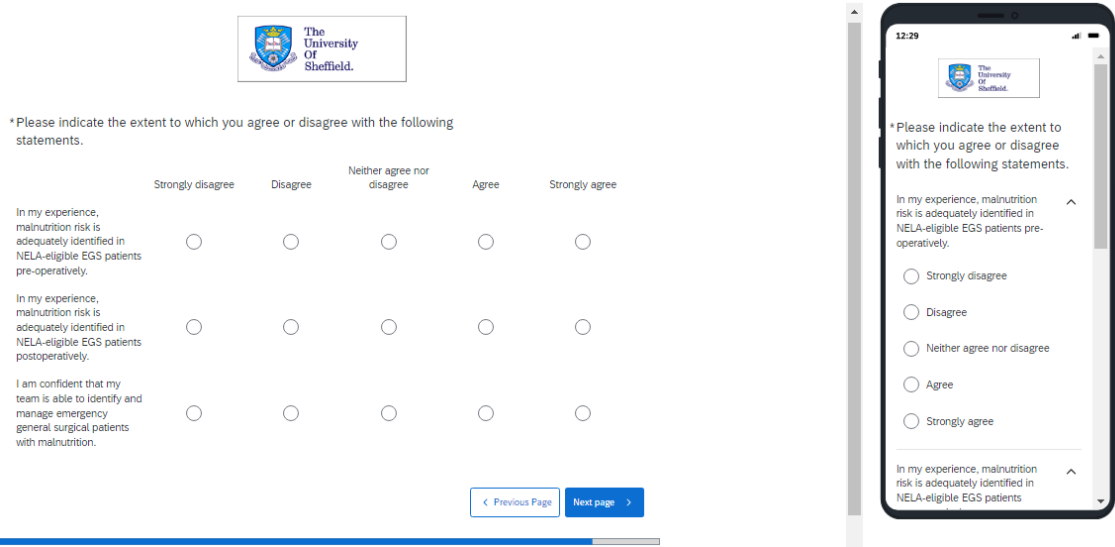
End of Block: Email request

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Additional file 7: Study user interface



Additional File Figure 4: Computer and mobile phone views of the first page of the survey



Additional File Figure 5: Computer and mobile phone views of the survey showing Q45, a Likert matrix

## Supplementary tables for Paper 2

**Table S8:** Who performs malnutrition screening before, or after, emergency surgery?

| Role                            | Dietitian | NST       | General surgeons | ICU team  | Geriatrician | Anaesthetists | Nurses    | HCA     | Don't know | Other   |
|---------------------------------|-----------|-----------|------------------|-----------|--------------|---------------|-----------|---------|------------|---------|
| <b>Before emergency surgery</b> |           |           |                  |           |              |               |           |         |            |         |
| <b>Anaesthetists</b>            | 43.9 (18) | 7.3 (3)   | 34.1 (14)        | 2.4 (1)   | 14.6 (6)     | 9.8 (4)       | 41.5 (17) | 9.8 (4) | 26.8 (11)  | 0 (0)   |
| <b>Surgeons</b>                 | 30.5 (25) | 19.5 (16) | 47.6 (39)        | 9.8 (8)   | 4.9 (4)      | 6.1 (5)       | 64.6 (53) | 2.4 (2) | 1.2 (1)    | 1.2 (1) |
| <b>Total</b>                    | 35.0 (43) | 15.4 (19) | 43.1 (53)        | 7.3 (9)   | 8.1 (10)     | 7.3 (9)       | 56.9 (70) | 4.9 (6) | 9.8 (12)   | 0.8 (1) |
| <b>After emergency surgery</b>  |           |           |                  |           |              |               |           |         |            |         |
| <b>Anaesthetists</b>            | 34.3 (24) | 7.1 (5)   | 15.7 (11)        | 11.4 (8)  | 8.6 (6)      | 0 (0)         | 17.1 (12) | 1.4 (1) | 4.3 (3)    | 0 (0)   |
| <b>Surgeons</b>                 | 25.2 (61) | 13.2 (32) | 19.4 (47)        | 12.8 (31) | 3.7 (9)      | 0.8 (2)       | 21.5 (52) | 2.5 (6) | 0.8 (2)    | 0 (0)   |
| <b>Total</b>                    | 27.2 (85) | 11.9 (37) | 18.6 (58)        | 12.5 (39) | 4.8 (15)     | 0.6 (2)       | 20.5 (64) | 2.2 (7) | 1.6 (5)    | 0 (0)   |

Responses as % (n). Abbreviations: health care assistant (HCA); intensive care unit (ICU); nutrition screening team (NST).

**Table S9:** Reasons why screening or an assessment for malnutrition is not performed every time before or after surgery

| Question                                                    | Role | Lack of access to appropriate person | Lack of time | Would not change immediate management | Lack of appropriate training | Don't know | Other     |
|-------------------------------------------------------------|------|--------------------------------------|--------------|---------------------------------------|------------------------------|------------|-----------|
| <b>Screening for malnutrition before emergency surgery</b>  | A    | 52.9 (27)                            | 43.1 (22)    | 29.4 (15)                             | 37.3 (19)                    | 31.4 (16)  | 2.0 (1)   |
|                                                             | S    | 30.0 (24)                            | 55.0 (44)    | 45.0 (36)                             | 16.3 (13)                    | 16.3 (13)  | 6.3 (5)   |
|                                                             | T    | 38.9 (51)                            | 50.4 (66)    | 38.9 (51)                             | 24.4 (32)                    | 22.1 (29)  | 4.6 (6)   |
| <b>Screening for malnutrition after emergency surgery</b>   | A    | 27.8 (10)                            | 5.6 (2)      | 0 (0)                                 | 22.2 (8)                     | 41.7 (15)  | 2.8 (1)   |
|                                                             | S    | 25.6 (20)                            | 5.1 (4)      | 16.7 (13)                             | 11.5 (9)                     | 26.9 (21)  | 14.1 (11) |
|                                                             | T    | 26.3 (30)                            | 5.3 (6)      | 11.4 (13)                             | 14.9 (17)                    | 31.6 (36)  | 10.5 (12) |
| <b>Assessment for malnutrition before emergency surgery</b> | A    | 30.2 (19)                            | 22.2 (14)    | 7.9 (5)                               | 22.2 (14)                    | 17.5 (11)  | 0 (0)     |
|                                                             | S    | 22.4 (32)                            | 32.9 (47)    | 24.5 (35)                             | 7.0 (10)                     | 11.9 (17)  | 1.4 (2)   |
|                                                             | T    | 24.8 (51)                            | 29.6 (61)    | 19.4 (40)                             | 11.7 (24)                    | 13.6 (28)  | 1.0 (2)   |
| <b>Assessment for malnutrition after emergency surgery</b>  | A    | 33.3 (12)                            | 0 (0)        | 0 (0)                                 | 19.4 (7)                     | 47.2 (17)  | 0 (0)     |
|                                                             | S    | 37.6 (32)                            | 7.1 (6)      | 12.9 (11)                             | 11.8 (10)                    | 25.9 (22)  | 4.7 (4)   |
|                                                             | T    | 36.4 (44)                            | 5.0 (6)      | 9.1 (11)                              | 14.0 (17)                    | 32.2 (39)  | 3.3 (4)   |

Responses as % (n). Abbreviations: Anaesthetists (A); surgeons (S); total (T).

**Table S10:** Screening or assessment methods routinely used to determine malnutrition risk

| Role                 | MNA-SF  | MST      | MUST      | NRS-2002 | NRI   | WAASP   | SNAQ    | SGA     | NUTRIC  | None  | Don't know | Other   |
|----------------------|---------|----------|-----------|----------|-------|---------|---------|---------|---------|-------|------------|---------|
| <b>Anaesthetists</b> | 0 (0)   | 1.3 (1)  | 34.2 (26) | 0 (0)    | 0 (0) | 0 (0)   | 0 (0)   | 0 (0)   | 1.3 (1) | 0 (0) | 61.8 (47)  | 1.3 (1) |
| <b>Surgeons</b>      | 0.8 (1) | 8.4 (10) | 57.2 (68) | 0.8 (1)  | 0 (0) | 7.6 (9) | 1.7 (2) | 3.4 (4) | 0.8 (1) | 0 (0) | 17.6 (21)  | 1.7 (2) |
| <b>Total</b>         | 0.5 (1) | 5.6 (11) | 48.2 (94) | 0.5 (1)  | 0 (0) | 4.6 (9) | 1.0 (2) | 2.1 (4) | 1.0 (2) | 0 (0) | 34.9 (68)  | 1.5 (3) |

Responses as % (n). Abbreviations: Mini Nutritional Assessment-Short Form (MNA-SF); Malnutrition Screening Tool (MST); Malnutrition Universal Screening Tool (MUST); Nutrition Risk Score-2002 (NRS-2002); Nutrition Risk Index (NRI); Weight, Appetite, Ability to eat, Stress factor, Pressure ulcer/wound (WAASP); Short Nutritional Assessment Questionnaire (SNAQ); Subjective Global Assessment (SGA); Nutrition Risk in Critically ill (NUTRIC).

**Table S11:** Anthropometric methods routinely used to determine malnutrition risk

| Role          | Weight history | Body mass index | Mid-upper arm circumference | Skin fold thickness | None     | Don't know | Other   |
|---------------|----------------|-----------------|-----------------------------|---------------------|----------|------------|---------|
| Anaesthetists | 25.5 (28)      | 36.4 (40)       | 3.6 (4)                     | 2.7 (3)             | 2.7 (3)  | 28.2 (31)  | 0.9 (1) |
| Surgeons      | 40.8 (64)      | 36.3 (57)       | 4.5 (7)                     | 3.2 (5)             | 5.1 (8)  | 8.3 (13)   | 1.9 (3) |
| Total         | 34.5 (92)      | 36.3 (97)       | 4.1 (11)                    | 3.0 (8)             | 4.1 (11) | 16.5 (44)  | 1.5 (4) |

Responses as % (n). Abbreviations: weight history (percentage weight loss over a fixed period of time); body mass index (BMI); skin fold thickness (eg triceps).



**Table S12:** Biochemical markers routinely used to determine malnutrition risk

| Role          | Albumin    | Pre-albumin | Total protein | C-reactive protein | Transferrin | None     | Don't know | Other   |
|---------------|------------|-------------|---------------|--------------------|-------------|----------|------------|---------|
| Anaesthetists | 44.7 (46)  | 1.9 (2)     | 12.6 (13)     | 8.7 (9)            | 1.9 (2)     | 6.8 (7)  | 23.3 (24)  | 0 (0)   |
| Surgeons      | 43.2 (76)  | 1.1 (2)     | 16.5 (29)     | 24.4 (43)          | 5.7 (10)    | 5.7 (10) | 2.3 (4)    | 1.9 (2) |
| Total         | 43.7 (122) | 1.4 (4)     | 15.1 (42)     | 18.6 (52)          | 4.3 (12)    | 6.1 (17) | 10.0 (28)  | 1.9 (2) |

Responses as % (n).

**Table S13:** Body composition tests routinely used to determine malnutrition risk

| Role          | Bioelectrical impedance | Computerised tomography | Bone density scan | None       | Don't know | Other   |
|---------------|-------------------------|-------------------------|-------------------|------------|------------|---------|
| Anaesthetists | 1.4 (1)                 | 0 (0)                   | 0 (0)             | 54.8 (40)  | 43.8 (32)  | 0 (0)   |
| Surgeons      | 0 (0)                   | 8.6 (8)                 | 0 (0)             | 81.7 (76)  | 8.6 (8)    | 1.1 (1) |
| Total         | 0.6 (1)                 | 4.8 (8)                 | 0 (0)             | 69.9 (116) | 24.1 (40)  | 0.6 (1) |

Responses as % (n). Abbreviations: Computerised tomography (CT) scan (eg skeletal muscle index, psoas muscle density); body density scan (DEXA).

**Table S14:** Functional tests routinely used to determine malnutrition risk

| Role          | Self-reported physical function | Hand grip strength | Timed get-up-and-go | Stair climb | Gait speed | None      | Don't know | Other   |
|---------------|---------------------------------|--------------------|---------------------|-------------|------------|-----------|------------|---------|
| Anaesthetists | 14.3 (12)                       | 4.8 (4)            | 0 (0)               | 4.8 (4)     | 3.6 (3)    | 31.0 (26) | 40.5 (34)  | 1.2 (1) |
| Surgeons      | 7.1 (8)                         | 4.5 (5)            | 5.4 (6)             | 8.0 (9)     | 2.7 (3)    | 58.0 (65) | 10.7 (12)  | 4.8 (4) |
| Total         | 10.2 (20)                       | 4.6 (9)            | 3.1 (6)             | 6.6 (13)    | 3.1 (6)    | 46.4 (91) | 23.5 (46)  | 6.0 (5) |

Responses as % (n).

**Table S15:** Does your hospital have a surgical nutrition team/ Nutrition Support Team?

| Role          | Yes        | No        | Don't know |
|---------------|------------|-----------|------------|
| Anaesthetists | 49.3 (36)  | 6.8 (5)   | 43.8 (32)  |
| Surgeons      | 82.8 (77)  | 16.1 (15) | 1.1 (1)    |
| Total         | 68.1 (113) | 12.0 (20) | 19.9 (33)  |

Responses as % (n).

**Table S16:** Who performs a malnutrition assessment before, or after, emergency surgery?

| Role                            | Dietitian  | NST       | General surgeons | ICU team  | Geriatrician | Anaesthetists | Nurses    | HCA      | Don't know | Other |
|---------------------------------|------------|-----------|------------------|-----------|--------------|---------------|-----------|----------|------------|-------|
| <b>Before emergency surgery</b> |            |           |                  |           |              |               |           |          |            |       |
| <b>Anaesthetists</b>            | 23.9 (11)  | 8.7 (4)   | 17.4 (8)         | 2.2 (1)   | 6.5 (3)      | 6.5 (3)       | 13.0 (6)  | 4.3 (2)  | 17.4 (8)   | 0 (0) |
| <b>Surgeons</b>                 | 21.8 (34)  | 13.5 (21) | 25.6 (40)        | 4.5 (7)   | 1.9 (3)      | 4.5 (7)       | 20.5 (32) | 2.6 (4)  | 5.1 (8)    | 0 (0) |
| <b>Total</b>                    | 22.3 (45)  | 12.4 (25) | 23.8 (48)        | 4.0 (8)   | 3.0 (6)      | 5.0 (10)      | 18.8 (38) | 3.0 (6)  | 3.0 (16)   | 0 (0) |
| <b>After emergency surgery</b>  |            |           |                  |           |              |               |           |          |            |       |
| <b>Anaesthetists</b>            | 42.0 (29)  | 8.7 (6)   | 11.6 (8)         | 8.7 (6)   | 10.1 (7)     | 1.4 (1)       | 10.1 (7)  | 5.8 (4)  | 1.4 (1)    | 0 (0) |
| <b>Surgeons</b>                 | 30.1 (71)  | 14.0 (33) | 18.2 (43)        | 10.6 (25) | 3.4 (8)      | 1.7 (4)       | 18.6 (44) | 2.5 (6)  | 0.8 (2)    | 0 (0) |
| <b>Total</b>                    | 32.8 (100) | 12.8 (39) | 16.7 (51)        | 10.2 (31) | 4.9 (15)     | 1.6 (5)       | 16.7 (51) | 3.3 (10) | 1.0 (3)    | 0 (0) |

Responses as % (n). Abbreviations: health care assistant (HCA); intensive care unit (ICU); nutrition screening team (NST).

**Table S17:** Reasons why a nutrition pathway does not exist pre- or post-operatively

|                         | Role | Insufficient time to implement nutritional support for emergency patients | Implementing nutritional support for emergency patients would not improve patient outcomes (reduce complications or mortality) | Inadequate resources to implement nutritional support | Don't know | Other    |
|-------------------------|------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|------------|----------|
| <b>Pre-operatively</b>  | A    | 15.3 (9)                                                                  | 1.7 (1)                                                                                                                        | 23.7 (14)                                             | 59.3 (35)  | 0 (0)    |
|                         | S    | 34.3 (23)                                                                 | 7.5 (5)                                                                                                                        | 35.8 (24)                                             | 17.9 (12)  | 4.5 (3)  |
|                         | T    | 25.4 (32)                                                                 | 4.8 (6)                                                                                                                        | 30.2 (38)                                             | 37.3 (47)  | 2.4 (3)  |
| <b>Post-operatively</b> | A    | 3.3 (1)                                                                   | 0 (0)                                                                                                                          | 13.3 (4)                                              | 76.7 (23)  | 6.7 (2)  |
|                         | S    | 13.6 (3)                                                                  | 4.5 (1)                                                                                                                        | 36.4 (8)                                              | 31.8 (7)   | 13.6 (3) |
|                         | T    | 7.7 (4)                                                                   | 1.9 (1)                                                                                                                        | 23.1 (12)                                             | 57.7 (30)  | 9.6 (5)  |

Responses as % (n). Abbreviations: Anaesthetists (A); surgeons (S); total (T).

**Table S18:** Local barriers in identifying malnutrition risk in NELA-eligible EGS patients

| <b>Role</b> | <b>Acceptability of a malnutrition screening and/or assessment process</b> | <b>Clinical judgement is viewed as better than using a screening tool</b> | <b>Lack of organisational support</b> | <b>Lack of training and education</b> | <b>Lack of working relationship with dietetic team</b> | <b>Lack of evidence that adequate nutritional support improves outcomes in EGS</b> | <b>Lack of time to in the emergency setting</b> | <b>Unclear who is responsible for managing perioperative malnutrition</b> | <b>Other</b> |
|-------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------|---------------------------------------|--------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------------------------------------------------------|--------------|
| <b>A</b>    | 6.5 (10)                                                                   | 5.2 (8)                                                                   | 17.0 (26)                             | 18.3 (28)                             | 6.5 (10)                                               | 2.0 (3)                                                                            | 20.3 (31)                                       | 20.9 (32)                                                                 | 3.3 (5)      |
| <b>S</b>    | 6.5 (10)                                                                   | 13.0 (20)                                                                 | 15.6 (24)                             | 18.2 (28)                             | 5.8 (9)                                                | 1.9 (3)                                                                            | 26.0 (40)                                       | 11.7 (18)                                                                 | 1.3 (2)      |
| <b>T</b>    | 6.5 (20)                                                                   | 9.1 (28)                                                                  | 16.3 (50)                             | 18.2 (56)                             | 6.2 (19)                                               | 2.0 (6)                                                                            | 23.1 (71)                                       | 16.3 (50)                                                                 | 2.3 (7)      |

Responses as % (n). Abbreviations: Anaesthetists (A); surgeons (S); total (T).

**Table S19:** Correlation of participant responses with laparotomy volume in their hospital

| Question                                                                                                                                                                                                                             | n   | r value | Confidence intervals | p value |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---------|----------------------|---------|
| How often is screening for malnutrition risk performed prior to emergency surgery?                                                                                                                                                   | 117 | 0.000   | -0.159, 0.174        | 0.999   |
| How often is screening for malnutrition risk performed after emergency surgery?                                                                                                                                                      | 100 | 0.122   | -0.068, 0.310        | 0.225   |
| How often is an assessment of a patient's malnutrition status performed prior to emergency surgery?                                                                                                                                  | 101 | 0.068   | -0.131, 0.285        | 0.500   |
| How often is an assessment of a patient's malnutrition status performed after emergency surgery?                                                                                                                                     | 96  | 0.160   | -0.035, 0.337        | 0.118   |
| Following screening and/ or an assessment of malnutrition, if a patient is identified as at risk of malnutrition or malnourished, does a pathway or protocol exist to provide nutritional support pre-operatively in your hospital?  | 117 | 0.036   | -0.149, 0.219        | 0.698   |
| Following screening and/ or an assessment of malnutrition, if a patient is identified as at risk of malnutrition or malnourished, does a pathway or protocol exist to provide nutritional support post-operatively in your hospital? | 117 | -0.067  | -0.229, 0.105        | 0.475   |
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients pre-operatively                                                                                                                           | 117 | -0.188  | -0.360, -0.007       | 0.042*  |
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients postoperatively.                                                                                                                          | 117 | 0.124   | -0.067, 0.299        | 0.183   |
| I am confident that my team is able to identify and manage emergency general surgical patients with malnutrition.                                                                                                                    | 117 | 0.023   | -0.159, 0.197        | 0.801   |
| It would be beneficial to have a standard protocol or pathway for identifying and managing perioperative malnutrition as it might improve patient outcomes.                                                                          | 117 | 0.128   | -0.062, 0.310        | 0.168   |
| It would be beneficial to include malnutrition risk as part of the NELA data collection process.                                                                                                                                     | 117 | -0.032  | -0.210, 0.165        | 0.730   |

Calculations used data submitted to NELA's 7th report using Spearman's rank correlation. Significance determined by  $p = <0.05$ .



**Table S20:** Participants' responses relating to the frequency of screening and assessment for malnutrition pre- and post-operatively in hospitals with a NELA Lead for anaesthetics and surgery

| Question                                                    | Role | Never     | Rarely    | Occasionally | Regularly | All the time | Don't know |
|-------------------------------------------------------------|------|-----------|-----------|--------------|-----------|--------------|------------|
| <b>Screening for malnutrition before emergency surgery</b>  | A    | 15.6 (7)  | 28.9 (13) | 15.6 (7)     | 8.9 (4)   | 2.2 (1)      | 28.9 (13)  |
|                                                             | S    | 4.4 (2)   | 35.6 (16) | 31.1 (14)    | 22.2 (10) | 4.4 (2)      | 2.2 (1)    |
|                                                             | T    | 10.0 (9)  | 32.2 (29) | 23.3 (21)    | 15.6 (14) | 3.3 (3)      | 15.6 (14)  |
| <b>Screening for malnutrition after emergency surgery</b>   | A    | 0.0 (0)   | 11.1 (5)  | 8.9 (4)      | 17.8 (8)  | 6.7 (3)      | 55.6 (25)  |
|                                                             | S    | 0.0 (0)   | 6.7 (3)   | 8.9 (4)      | 60.0 (27) | 24.4 (11)    | 0.0 (0)    |
|                                                             | T    | 0.0 (0)   | 8.9 (8)   | 8.9 (8)      | 38.9 (35) | 15.6 (14)    | 27.8 (25)  |
| <b>Assessment for malnutrition before emergency surgery</b> | A    | 13.3 (6)  | 20.0 (9)  | 6.7 (3)      | 6.7 (3)   | 2.2 (1)      | 51.1 (23)  |
|                                                             | S    | 8.9 (4)   | 51.1 (23) | 15.6 (7)     | 22.2 (10) | 0.0 (0)      | 2.2 (1)    |
|                                                             | T    | 11.1 (10) | 35.6 (32) | 11.1 (10)    | 14.4 (13) | 1.1 (1)      | 26.7 (24)  |
| <b>Assessment for malnutrition after emergency surgery</b>  | A    | 2.2 (1)   | 4.4 (2)   | 15.6 (7)     | 17.8 (8)  | 6.7 (3)      | 53.3 (24)  |
|                                                             | S    | 0.0 (0)   | 8.9 (4)   | 20.0 (9)     | 51.1 (23) | 20.0 (9)     | 0.0 (0)    |
|                                                             | T    | 1.1 (1)   | 6.7 (6)   | 17.8 (16)    | 34.4 (31) | 13.3 (12)    | 26.7 (24)  |

Responses as % (n). Abbreviations: Anaesthetists (A); surgeons (S); total (T).

**Table S21:** Participants' responses relating to the presence of nutrition pathways pre- and post-operatively if a patient was at risk of malnutrition or malnourished in hospitals with a NELA Lead for anaesthetics and surgery

| Question                                                | Role | Yes       | No        |
|---------------------------------------------------------|------|-----------|-----------|
| Pathway to provide nutritional support pre-operatively  | A    | 22.2 (10) | 77.8 (35) |
|                                                         | S    | 51.1 (23) | 48.9 (22) |
|                                                         | T    | 36.7 (33) | 63.3 (57) |
| Pathway to provide nutritional support post-operatively | A    | 60.0 (27) | 40.0 (18) |
|                                                         | S    | 82.2 (64) | 17.8 (8)  |
|                                                         | T    | 71.1 (64) | 28.9 (26) |

Responses as % (n). Abbreviations: Anaesthetists (A); surgeons (S); total (T).

**Table S22:** Distribution of participants' responses relating to perceptions regarding overall management of malnutrition risk in NELA-eligible patients in hospitals with a NELA Lead for anaesthetics and surgery

| Question                                                                                                                                                    | Role | Strongly disagree | Disagree  | Neither agree nor disagree | Agree     | Strongly agree |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------|-----------|----------------------------|-----------|----------------|
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients pre-operatively                                                  | A    | 20.0 (9)          | 44.4 (20) | 17.8 (8)                   | 11.1 (5)  | 6.7 (3)        |
|                                                                                                                                                             | S    | 11.1 (5)          | 33.3 (15) | 28.9 (13)                  | 2.2 (10)  | 4.4 (2)        |
|                                                                                                                                                             | T    | 15.6 (14)         | 38.9 (35) | 23.3 (21)                  | 16.7 (15) | 5.6 (5)        |
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients postoperatively.                                                 | A    | 11.1 (5)          | 31.1 (14) | 37.8 (17)                  | 15.6 (7)  | 4.4 (2)        |
|                                                                                                                                                             | S    | 0.0 (0)           | 13.3 (6)  | 13.3 (6)                   | 57.8 (26) | 15.6 (7)       |
|                                                                                                                                                             | T    | 5.6 (5)           | 22.2 (20) | 25.6 (23)                  | 36.7 (33) | 10.0 (9)       |
| I am confident that my team is able to identify and manage emergency general surgical patients with malnutrition.                                           | A    | 11.1 (5)          | 20.0 (9)  | 35.6 (16)                  | 28.9 (13) | 4.4 (2)        |
|                                                                                                                                                             | S    | 2.2 (1)           | 4.4 (2)   | 24.4 (11)                  | 60.0 (27) | 8.9 (4)        |
|                                                                                                                                                             | T    | 6.7 (6)           | 12.2 (11) | 30.0 (27)                  | 44.4 (40) | 6.7 (6)        |
| It would be beneficial to have a standard protocol or pathway for identifying and managing perioperative malnutrition as it might improve patient outcomes. | A    | 2.2 (1)           | 0.0 (0)   | 8.9 (4)                    | 44.4 (20) | 44.4 (20)      |
|                                                                                                                                                             | S    | 2.2 (1)           | 6.7 (3)   | 13.3 (6)                   | 55.6 (25) | 22.2 (10)      |
|                                                                                                                                                             | T    | 2.2 (2)           | 3.3 (3)   | 11.1 (10)                  | 50.0 (45) | 33.3 (30)      |
| It would be beneficial to include malnutrition risk as part of the NELA data collection process.                                                            | A    | 4.4 (2)           | 2.2 (1)   | 22.2 (10)                  | 37.8 (17) | 33.3 (15)      |
|                                                                                                                                                             | S    | 4.4 (2)           | 8.9 (4)   | 17.8 (8)                   | 46.7 (21) | 22.2 (10)      |
|                                                                                                                                                             | T    | 4.4 (4)           | 5.6 (5)   | 20.0 (18)                  | 42.2 (38) | 27.8 (25)      |

Responses as % (n). Abbreviations: Anaesthetists (A); surgeons (S); total (T).

**Table S23:** Association of participant response according to professional role for hospitals with a NELA Lead for anaesthetics and surgery

| Question                                                                                                                                                                                                                             | n  | p value |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---------|
| How often is screening for malnutrition risk performed prior to emergency surgery?                                                                                                                                                   | 76 | 0.027*  |
| How often is screening for malnutrition risk performed after emergency surgery?                                                                                                                                                      | 65 | 0.029*  |
| How often is an assessment of a patient's malnutrition status performed prior to emergency surgery?                                                                                                                                  | 66 | 0.244   |
| How often is an assessment of a patient's malnutrition status performed after emergency surgery?                                                                                                                                     | 66 | 0.178   |
| Following screening and/ or an assessment of malnutrition, if a patient is identified as at risk of malnutrition or malnourished, does a pathway or protocol exist to provide nutritional support pre-operatively in your hospital?  | 90 | 0.004*  |
| Following screening and/ or an assessment of malnutrition, if a patient is identified as at risk of malnutrition or malnourished, does a pathway or protocol exist to provide nutritional support post-operatively in your hospital? | 90 | 0.020*  |
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients pre-operatively                                                                                                                           | 90 | 0.083   |
| In my experience, malnutrition risk is adequately identified in NELA-eligible EGS patients postoperatively.                                                                                                                          | 90 | <0.001* |
| I am confident that my team is able to identify and manage emergency general surgical patients with malnutrition.                                                                                                                    | 90 | <0.001* |
| It would be beneficial to have a standard protocol or pathway for identifying and managing perioperative malnutrition as it might improve patient outcomes.                                                                          | 90 | 0.019*  |
| It would be beneficial to include malnutrition risk as part of the NELA data collection process.                                                                                                                                     | 90 | 0.348   |

Significance determined by Mann Whitney U with  $p = <0.05$  deemed significant.

**Table S24:** A summary of the free text comments regarding screening and assessment for malnutrition pre- and post-operatively

|                   | Pre-operatively                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Post-operatively                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Screening</b>  | <ul style="list-style-type: none"> <li>• Personnel are not aware of importance of nutritional status</li> <li>• Lack of awareness among consultant surgeons</li> <li>• Operations occur shortly after admission, hence no time to implement changes prior to surgery</li> <li>• Although nurses complete nutrition assessments on all patients, I don't think the surgical team consider it even where there is time</li> <li>• Not part of routine documentation</li> </ul> | <ul style="list-style-type: none"> <li>• If a patient goes home quickly, they may not have been reassessed</li> <li>• Lack of availability of trained personnel</li> <li>• Involvement of dietitians, nurses and surgeons when patient is on ITU (and not on ward)</li> <li>• General hospital 'chaos' and bed moves</li> <li>• Busy ward rounds means that type 1 intestinal failure is not recognised early enough</li> </ul> |
| <b>Assessment</b> | <ul style="list-style-type: none"> <li>• Patients are only clinically assessed by surgeon and if required referred to dietitian.</li> <li>• Lack of awareness and education</li> </ul>                                                                                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>• Patients recover quickly and subsequently discharged, so an assessment is not needed</li> <li>• General patient dispersal throughout the hospital</li> </ul>                                                                                                                                                                                                                           |

## Appendix 3

This section includes:

- Additional files to support Paper 3
  - **Additional File 1:** Research governance
  - **Additional File 2:** Ethical approval from University of Sheffield
  - **Additional File 3:** Evidence of support from the Association of Surgeons of Great Britain and Ireland (ASGBI)
  - **Additional File 4:** Extension of support from the Association of Surgeons of Great Britain and Ireland (ASGBI)
  - **Additional File 5:** Participant invitation email
  - **Additional File 6:** Participant Information Sheet
  - **Additional File 7:** Written consent form
  - **Additional File 8:** Methodology
  - **Additional File 9:** Interview schedule
  - **Additional File 10:** Framework development
  - **Additional File 11:** Additional results for Paper 3
- Supplementary tables for Paper 3
  - **Table S25:** Illustrative quotes related to how surgeons identify malnutrition
  - **Table S26:** Illustrative quotes related to barriers encountered by surgeons
  - **Table S27:** Illustrative quotes related to clinical decision making by surgeons

## Additional files to support Paper 3

### Additional file 1: Research governance

#### **Ethical approval**

This study was reviewed the University of Sheffield Medical School's Ethics Review Committee and approval was granted on 7<sup>th</sup> December 2022 (UREC 05043). NHS Research Ethics Committee approval was not required as the participants were NHS staff were recruited only by virtue of their profession.

#### **Informed consent**

Potential participants were emailed an invitation to read a Participant Information Sheet, which explained the identity of the researchers, contact details, the purpose for conducting the survey and how the data would be used. It also included information on how long the interview was estimated to take (maximum one hour), and who to contact if any issues arise. It was explicit that their involvement in the study was voluntary. Written, informed consent was obtained by participants prior to interview, and verbally confirmed at the start of the interview. Participants were advised they can withdraw from the survey up until submission of their survey form.

#### **Confidentiality**

Interview transcripts were pseudo-anonymised to protect identity of the participant. A list of participant names was stored separately from participant details. Databases were password protected and stored as per the university-approved data management plan.

## Additional file 2: Ethical approval from University of Sheffield



Downloaded: 26/05/2024

Approved: 07/12/2022

Daniel Ashmore

Registration number:

210200731 Oncology

Programme: Postgraduate Research (PGR)

Dear Daniel

**PROJECT TITLE:** How do we identify malnutrition in emergency general surgery: a mixed methods study

**APPLICATION:** Reference Number 050436

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 07/12/2022 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 050436 (form submission date: 11/11/2022); (expected project end date: 01/12/2023).
- Participant information sheet 1113822 version 1 (11/11/2022).
- Participant consent form 1113823 version 1 (11/11/2022).

The reviewers have left the following comments regarding the application:

Although this involves the NHS, in terms of surveying staff, my understanding is that NHS approval is not required within this context. The following amendments to this application have been approved:

- Amendment approved: 10/08/2023

If during the course of the project you need to [deviate significantly from the above-approved documentation](#) please inform me since written approval will be required.

Your responsibilities in delivering this research project are set out at the end of this letter.

Yours sincerely

Charlotte Cole

Ethics Admin

Medical School

Please note the following responsibilities of the researcher in delivering the research project:

- The project must abide by the University's Research Ethics Policy: <https://www.sheffield.ac.uk/research-services/ethics-integrity/policy> The project must abide by



the University's Good Research & Innovation Practices Policy:  
[https://www.sheffield.ac.uk/polopoly\\_fs/1.671066!/file/GRIPPolicy.pdf](https://www.sheffield.ac.uk/polopoly_fs/1.671066!/file/GRIPPolicy.pdf)

- The researcher must inform their supervisor (in the case of a student) or Ethics Admin (in the case of a member of staff) of any significant changes to the project or the approved documentation.
- The researcher must comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
- The researcher is responsible for effectively managing the data collected both during and after the end of the project in line with best practice, and any relevant legislative, regulatory or contractual requirements.



## Additional file 3: Support from the Association of Surgeons of Great Britain and Ireland

1<sup>st</sup> December 2022

Dear Daniel

It is my pleasure to approve your application for your study to have ASGBI Support.

**Title of study: How do we identify malnutrition in emergency general surgery: a mixed methods study**

**Study Team: Daniel L Ashmore, Timothy R Wilson, Vanessa Halliday, Matthew J Lee**

**Start date of support: 1<sup>st</sup> December 2022**

We agree (ASGBI and the Research Committee) to support your work for 12 months, but please remember you can re-apply.

We agree to the following:

**1. Up to 5 posts on our social media platform.**

*Text provided must be a maximum of 280 characters, including any links. Image size width of 600px.*

**2. Space on the ASGBI new research page that allows links to protocols and contacts. This can be actively updated at your request during your year of support.**

*Please follow the format shown here - <https://www.asgbi.org.uk/research>*

**3. Inclusion into ASGBI emails at least once a year.**

*A maximum of 150 words of text and logo, no greater than 300 x 300px, or alternatively, an advert supplied as a jpeg no greater than 600 x 600px.*

In return for ASGBI Support, we would like acknowledgment of support on published papers and presentations (logo and/or words). We also expect you to withhold the values of ASGBI and encourage future researchers.

We are continuing to evolve ASGBI Research and welcome any ideas or suggestions during your time with us.

Best wishes,

**Professor Susan J Moug**  
**Director of Research, ASGBI**



## Additional file 4: Extension of support from the Association of Surgeons of Great Britain and Ireland

1<sup>st</sup> December 2023

Dear Daniel

It is my pleasure to approve your application for your study to have ASGBI Support.

**Title of study: How do we identify malnutrition in emergency general surgery: a mixed methods study**

**Study Team: Daniel L Ashmore, Timothy R Wilson, Vanessa Halliday, Matthew J Lee**

**Start date of support: 1<sup>st</sup> December 2023**

We agree (ASGBI and the Research Committee) to support your work for 12 months, but please remember you can re-apply.

We agree to the following:

**1. Up to 5 posts on our social media platform.**

*Text provided must be a maximum of 280 characters, including any links. Image size width of 600px.*

**2. Space on the ASGBI new research page that allows links to protocols and contacts. This can be actively updated at your request during your year of support.**

*Please follow the format shown here - <https://www.asgbi.org.uk/research>*

**3. Inclusion into ASGBI emails at least once a year.**

*A maximum of 150 words of text and logo, no greater than 300 x 300px, or alternatively, an advert supplied as a jpeg no greater than 600 x 600px.*

In return for ASGBI Support, we would like acknowledgment of support on published papers and presentations (logo and/or words). We also expect you to withhold the values of ASGBI and encourage future researchers.

We expect at least one abstract to be submitted for the ASGBI Congress. We also expect you to withhold the values of ASGBI and encourage future researchers.

We are continuing to evolve ASGBI Research and welcome any ideas or suggestions during your time with us.

Best wishes,

**Professor Susan J Moug**  
**Director of Research, ASGBI**



## Additional file 5: Participant invitation email



The  
University  
Of  
Sheffield.



### **Nutrition in Emergency General Surgery:** **How do we identify malnutrition among Emergency General Surgery patients?**

Dear Emergency General Surgery consultant

We are inviting you to participate in the above research study to investigate how we identify malnutrition in emergency general surgery (EGS). In short, this will involve an online, semi-structured interview lasting up to an hour exploring how you identify malnutrition in EGS patients, why this may be the case, focussing on any barriers and facilitators you encounter.

This study is part of a set of wider research studies, and will contribute towards my PhD at the University of Sheffield.

As you will be aware, EGS provides complex management for patients admitted with an acute surgical pathology. However, identifying the most high risk patients in need of nutritional support can be difficult. Given malnutrition is a specific risk factor for mortality in EGS patients, and the 'delay' to starting nutritional support is often between admission and the decision for nutritional support, this underlies the remit of this study.

Any publications from this study will maintain your confidentiality such that no-one can work out that you participated in the study.

A Participant Information Sheet can be found at <https://bit.ly/PISnutritioninEGS>.

If you wish to take part, please contact Daniel at [dlashmore1@sheffield.ac.uk](mailto:dlashmore1@sheffield.ac.uk) and he will contact you to make further arrangements or use this form <https://bit.ly/signupnutritioninEGS>.

**Thank you for considering taking part in the study.**

Many thanks for your support in advance

Mr Daniel Ashmore

Clinical Research Fellow

Research and Innovation Team, Research Office, Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust, West Block, Doncaster Royal Infirmary, Armthorpe Road  
Doncaster, DN2 5LT

Email: [dlashmore1@sheffield.ac.uk](mailto:dlashmore1@sheffield.ac.uk)

Invitation 1.1 dated 10/11/2022

## Additional file 6: Participant Information Sheet



### **Nutrition in Emergency General Surgery:** **How do we identify malnutrition among Emergency General Surgery patients?**

#### **Participant Information Sheet**

Dear Colleague

We are writing to you to invite you to take part in the above research study to investigate nutrition in emergency general surgery (EGS). This study is part of a wider research study, and will contribute towards my PhD at the University of Sheffield. If there is anything that is not clear, or if you would like more information, please ask us.

#### **1. What is the purpose of the study?**

This study will primarily aim to explore how emergency general surgery (EGS) patients are identified as being malnourished, why this is the case and the barriers to doing so. These will be assessed using semi-structured interviews with consultants that undertake EGS work as part of their clinical role.

Emergency general surgery provides complex management for patients admitted with an acute surgical pathology. It is known that a subset of EGS patients are very high risk patients in the UK and worldwide. EGS patients also have an approximately eight times greater risk of mortality than elective admissions. In order to provide nutritional support to patients, the process can be considered to consist of three steps: identification, stratification and implementation. Each step is dependent on the previous. Evidence suggests that once the decision for nutritional support is made, the process of implementing it is relatively quick. The 'delay' to starting nutritional support is within the decision making process of how we identify malnourished EGS patients from the point of admission to the time of decision that they need some form of nutritional support. In order to make subsequent changes to the process, it is important to understand why this is the case and the contextual barriers within which these complex decisions are made.

#### **2. What will I have to do if I take part? Please take time to read and understand what the study will involve. You can speak to the research team who will answer any questions you may have.**

This study involves a single semi-structured interview lasting a maximum of an hour. Essentially, it will aim to identify how you identify malnutrition in EGS patients, why this may be the case, focussing on any barriers and facilitators you encounter.

The interview will use an online platform with data security approved by the University of Sheffield (GoogleMeet, Google Palo Alto, CA.). There may be other members of my supervisory team present in order to provide personal feedback on the interview style. They will be silent and non-visible during the interview. Interviews will be video and audio recorded using GoogleMeet and transcribed verbatim by DA into Microsoft Word. Prior to any involvement you will be required to sign an electronic consent form to agree to be interviewed, and we will verbally confirm this on the day as well.

### **3. What alternatives are there if I don't take part?**

If you decide not to take part in the study, then we will respect your wishes. There will be other studies we may approach you about in the future.

### **4. What are the benefits of taking part?**

The information we collect from you and others will hopefully help improve the nutritional care for surgical patients in the future. You will therefore have assisted in this process.

### **5. What are the disadvantages and risks associated with taking part in this study?**

Apart from your time involved in the study, there is no additional risk to your health from taking part in the study.

### **6. Will I get paid for taking part?**

No, you will not receive any payment for taking part in this study.

### **7. What will happen if I don't want to carry on with the study?**

You can stop taking part in the study at any point until publication of any findings, without giving any reason. If this is during the interview, it will be terminated and any recordings deleted and not transcribed. If you decide to terminate your involvement after the interview has been transcribed, all data will be deleted including the transcription and recording of the interview.

### **8. What if there is a problem during the study?**

If you have any concerns or questions about this study, please contact Mr Daniel Ashmore, Clinical Research Fellow. Details can be found at the bottom of this information leaflet. If you have concerns about the way the interview was conducted or safeguarding concerns, please raise these by contacting Mr Matthew Lee or Dr Vanessa Halliday, supervisors of Mr Ashmore's PhD. Alternatively, Prof Allan Pacey (Head of Departments of Oncology and Metabolism and Infection, Immunity and Cardiovascular Disease; not involved in the research study) can be contacted. It is also recommended that any concerns are raised by the NELA Lead via the Local Hospital safeguarding policy as well.

### **9. Will my taking part in this study be kept confidential?**

Yes. Each participant will be given a unique study ID number that will be recorded on the enrolment log along with their interview and consent date. As such, your data will be anonymous from this point with the removal of identifiable data. Participants will not be identifiable from their study IDs, unless absolutely necessary such as for withdrawal of consent after the interview has taken place. This means that most members of the research team will not know your name, only your study ID. The study ID will be used in the research database. Your study data (the recorded interview) will be transcribed verbatim and stored securely and analysed at the University of Sheffield. The original recording will then be deleted. In this research study we will possibly use quotes from the interview in any publications arising from the study. We will write our reports in a way that no-one can work out that you took part in the study.

You will be offered to be kept informed regarding the findings of this study or any future studies relating to nutrition in emergency general surgery. If you provide your email address at the end of the interview then we will use your email address only for this purpose and it will not be passed on to any other party. Your email address will not be linked to your interview responses.

### **10. What are the choices about how my information is used?**

You can stop taking part in the study at any point until publication of any findings, without giving any reason.

**11. What do you do with my information?**

The University of Sheffield is the Sponsor for this study. The study data will be stored securely and analysed at the University of Sheffield. The University of Sheffield will act as the data controller for this study. This means that the University of Sheffield is responsible for looking after your information and using it properly.

**12. What will happen to the results of the study?**

The results will be presented at conferences and published in peer-reviewed scientific journals. If a publication results from this research, it will be made available to you at the following academic website: <http://www.ncbi.nlm.nih.gov/pubmed/>. Under no circumstance will you be identified by name in any presentation or report.

**13. Who is organising and reviewing the study?**

This study has been reviewed by the University of Sheffield's Research Ethics Committee, who protect your safety, rights, wellbeing and dignity. The University of Sheffield has overall responsibility for the study. This study is unfunded.

**14. Who do I contact if I need further information?**

Mr Daniel Ashmore  
PhD student/ Clinical Research Fellow  
University of Sheffield  
[dashmore1@sheffield.ac.uk](mailto:dashmore1@sheffield.ac.uk)

Research supervisors:  
Mr Matthew Lee  
Project Supervisor  
[m.j.lee@sheffield.ac.uk](mailto:m.j.lee@sheffield.ac.uk)

Dr Vanessa Halliday  
Project Supervisor  
[vanessa.halliday@sheffield.ac.uk](mailto:vanessa.halliday@sheffield.ac.uk)

University of Sheffield (independent contact, not involved in the research study) for any concerns  
Prof Allan Pacey  
Head of Department  
[a.pacey@sheffield.ac.uk](mailto:a.pacey@sheffield.ac.uk)

**Thank you for reading this leaflet and considering taking part in the study.**

## Additional file 7: Written consent form

### **Nutrition in Emergency General Surgery:** **How do we identify malnutrition among Emergency General Surgery** **patients?**

#### **Interview Consent Form**

*Participant to initial each box*

1. I confirm that I have read and understand the participant information leaflet: version 1.2, dated 10/11/22, for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

☐

2. I understand that my participation in this study is voluntary and that I am free to withdraw at any time without giving a reason and without my legal rights being affected.

☐

3. I understand that quotes from my interview may be used within written reports or publications and that any quotes would be completely anonymous and could not be linked to me in any way.

☐

4. I understand that relevant interview data collected during the study may be looked at by individuals from the University of Sheffield where it is relevant to my taking part in this research. I give permission for these individuals to have access to these records.

☐

5. I agree for my data to be stored by the University of Sheffield (the Sponsor) for 5 years after the study has ended.

☐

6. I accept that, in the unlikely event of loss of my capacity, the research team will retain my personal data already collected and will continue to use this data for the sole purposes for which consent was sought.

☐

7. I agree to take part in the above study.

☐

Name of Participant \_\_\_\_\_

Name of interviewer Daniel Ashmore

Date \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Date

Participant Signature \_\_\_\_\_

Interviewer Signature



## **Additional file 8: Methodology**

An exploratory approach with semi-structured interviews was chosen to answer these questions with senior surgical decision-makers. An inductive approach was used for data analysis using the Framework Method, a type of thematic analysis(220,221). This approach is widely used in healthcare research and uses a systematic process. Semi-structured interviews allow the researcher to explore ideas with deeper questioning, whilst guiding the interview along a common framework or structure. It can help draw conclusions around themes according to individuals, or specific groups or organisations(221), including different hospital settings as in this study. The design and reporting of this explorative qualitative study is in accordance with published guidelines(228).

### **Sampling and setting**

Eligible participants were UK consultant surgeons that undertook EGS. Participants were selected in a purposive manner to ensure broad representation of EGS experience/practice with respect to sex, years qualified, and hospital setting. These included district general hospitals (DGH), teaching hospitals (TH) and intestinal failure units (IFU).

### **Recruitment**

Forty-eight EGS surgeons were contacted directly having registered an interest in previous studies conducted by the research team, of which nine responded and were interviewed. Members of the Association of Surgeons of Great Britain and Ireland (ASGBI), for which the study had received 'research support', were contacted by email and social media. Additional recruitment was via social media platforms to EGS specific groups and relevant clinical specialty associations. Potential participants who had expressed interest were given the participant information sheet and interviews arranged for those willing to take part at a mutually convenient time. Electronic signed consent with verbal confirmation at the start of the interview was obtained.

### **Inclusion and exclusion criteria**

#### **Inclusion criteria**

- Consultant surgeon in the UK
- Provide emergency general surgery service as part of role

#### **Exclusion criteria**

- Non-consultant surgeon in the UK

- Do not provide emergency general surgery service as part of role
- Unable to partake in an online interview
- Unable to consent

## Research team and reflexivity

Interviews were carried out by DA (PhD student/ surgical trainee) following formal training. A summary of the research team's role and experience is provided (**Additional File Table 8**). Reflexivity has many definitions(317). It can be summarised as the unconscious cognitive biases researchers bring to the study which may influence data and outcomes. Reflexivity was addressed in several ways throughout this study (**Additional File Table 9**). Namely, these include transparency with participants regarding DA's role and nature of the study; debriefing after interviews; immersion within the data through verbatim transcription by DA; dual review, coding and development of thematic framework between DA and DB, with agreement from the research team.

**Additional File Table 8:** Role and experience of each member of the research team.

| Research team | Role and experience                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DA</b>     | <ul style="list-style-type: none"> <li>• DA was the primary investigator.</li> <li>• DA is a PhD student and surgical trainee, and undertook all interviews.</li> <li>• DA has previous interview and qualitative research experience, which included using a structured approach to interview medical school applicants and formal training in Qualitative Research Design &amp; Analysis.</li> </ul> |
| <b>DB</b>     | <ul style="list-style-type: none"> <li>• DB is a surgical trainee</li> <li>• DB has coding and framework development experience.</li> </ul>                                                                                                                                                                                                                                                            |
| <b>TW</b>     | <ul style="list-style-type: none"> <li>• TW is a consultant surgeon</li> <li>• TW has experience in mixed methods research.</li> </ul>                                                                                                                                                                                                                                                                 |
| <b>ML</b>     | <ul style="list-style-type: none"> <li>• ML is a consultant surgeon and clinical researcher.</li> <li>• ML has experience in mixed methods research.</li> </ul>                                                                                                                                                                                                                                        |
| <b>VH</b>     | <ul style="list-style-type: none"> <li>• VH is a registered dietitian and Faculty Director for Medicine, Dentistry and Health at the University of Sheffield.</li> <li>• VH has experience in mixed methods research.</li> </ul>                                                                                                                                                                       |

**Additional File Table 9:** Personal, interpersonal, methodological, and contextual issues.

| Reflexivity orientation | Reflexivity processes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Personal</b>         | <ul style="list-style-type: none"> <li>• DA was the primary investigator and is a PhD student and surgical trainee.</li> <li>• DA has been senior surgical decision maker regarding which patients should be started on nutritional support for six years.</li> <li>• DA had trepidation regarding blind spots to the real underlying issues given his past experience.</li> <li>• DA's experience may also lead to a degree of tacit knowledge which may impact the quality of the interview and subsequently to missing data.</li> <li>• All participants were aware of my dual roles and research interest.</li> <li>• Much of this research was conceived and driven by personal clinical experiences, and reinforced following my previous PhD work which showed a wide disparity among surgeons in approach to and management of malnutrition.</li> </ul> |
| <b>Interpersonal</b>    | <ul style="list-style-type: none"> <li>• DA had previously worked with only 2/18 participants (P10 and P15). The recruitment strategy was developed to ensure participants were unlikely to have a pre-existing relationship.</li> <li>• To minimise power bias, these interviews were arranged after DA had experience interviewing other participants and began to immerse himself in the data and early analysis.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Methodological</b>   | <ul style="list-style-type: none"> <li>• Debriefing after interviews with the research team: The first three interview transcripts were reviewed by DA's supervisory team in order to refine DA's interview technique, aiming to limit tacit knowledge/'shared surgical knowledge' reducing the likelihood of missing data.</li> <li>• Immersion within the data through verbatim transcription by DA</li> <li>• Half of transcripts underwent dual review, independent coding and development of a thematic framework between DA and DB, with agreement from the research team.</li> <li>• Purposive recruitment of participants ensured an appropriate reflection of consultants regarding sex, years qualified, hospital setting and experience of intestinal failure.</li> </ul>                                                                            |
| <b>Contextual</b>       | <ul style="list-style-type: none"> <li>• Throughout recruitment, the research team were mindful of issues around surgical culture and diversity following the Kennedy report. Ensuring participants represented the surgical consultant body was important.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## Additional file 9: Interview schedule

This is an outline for a semi-structured interview (**Additional File Table 10**). This means that it adapted to the participant's response. The statements and questions below were intended as a guide to ensure relevant data is captured.

*'Hello, my name is Daniel and I'm from the Medical School at the University of Sheffield. Thank you for agreeing to talk to me about how you identify malnutrition among NELA-eligible EGS patients, and what your experiences are of these.*

*If you're still happy, I'll record the conversation as planned. Please try to not use names during the interview. However, I would like to reassure you that anything you say will be anonymised and that it won't be possible to identify you in any future publications or transcripts arising from this research. The digital recording will be transcribed and stored safely on the University of Sheffield's systems until this is done. After this, the written transcription will only include a study number and the digital recording will be deleted.*

*If at any point you want to stop for a break, then please do speak up and of course, if at any point you want to stop and withdraw altogether, then again, please do let me know.*

*[State record study ID number and date of the interview]'*

**Additional File Table 10:** Interview schedule

| Question                                                                                                                                                                                                                             | Prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Tell me about yourself?                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• How many years as a consultant? How many years have you been doing EGS?</li> <li>• What is your current hospital setting (IF unit, teaching, district)?</li> <li>• Have you ever trained or worked in IF unit previously?</li> <li>• Is there a Nutrition Support Team (NST) present in trust, and who makes up this team?</li> </ul>                                                                                                                                                                                                                                                                                                  |
| The following questions are all in relation to NELA-eligible EGS patients.                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 2. How do you identify if a patient is at risk of malnutrition or are malnourished?                                                                                                                                                  | <ul style="list-style-type: none"> <li>• Do you use any nutrition screening or 'assessment' tools?</li> <li>• Do you use any 'nutrition markers'?</li> <li>• Are there any other 'global measures'? eg complexity of patient/ surgery/ likelihood of postoperative problems like ileus?</li> <li>• Do you refer to the MUST score?</li> <li>• Do you refer on to anyone like a dietitian?</li> <li>• When do you first consider a patient's nutrition status? (pre- / post-operatively, and why?)</li> </ul>                                                                                                                                                                    |
| 3. Why is this?                                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>• Personal factors – previous training</li> <li>• Experience – have there been any specific cases that have shaped your decision making? To what extent does what you do (how you assess a patient) for a patient is shaped by past experience?</li> <li>• Patient factors – unwell, access to GI tract</li> <li>• Organisation factors – access to dietetic team? Does the process (ease of access) of delivering nutrition change their own practice in terms of how they identify malnutrition amongst EGS patients? Do local policies or protocols exist?</li> <li>• External factors – are there any guidelines you use?</li> </ul> |
| 4. Can you tell us what happens once a patient is identified as being at risk of malnutrition?                                                                                                                                       | <ul style="list-style-type: none"> <li>• Is there a referral to a dietitian for a full assessment?</li> <li>• Is there a reassessment? If so, at what stage? If not, why not?</li> <li>• How does this change anything for the patient?</li> <li>• Does it change when you operate? Or whom you operate on?</li> <li>• Who makes the decisions regarding starting nutritional support in your trust?</li> </ul>                                                                                                                                                                                                                                                                 |
| 5. Specifically with regards to when you're considering a patient's nutritional status, are there any difficulties or barriers you encounter that prevent you from making the decision sooner than you do normally or would like to? | <ul style="list-style-type: none"> <li>• Why is this?</li> <li>• Are there any issues with lack of time/ resources/ nutrition support team/ training/ team engagement?</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 6. Is there anything you would like to add which hasn't already been discussed?                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 7. Would being involved in further studies around this topic be something that interests you?                                                                                                                                        | Thank you for your time today, I really appreciate it.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## Additional file 10: Framework development

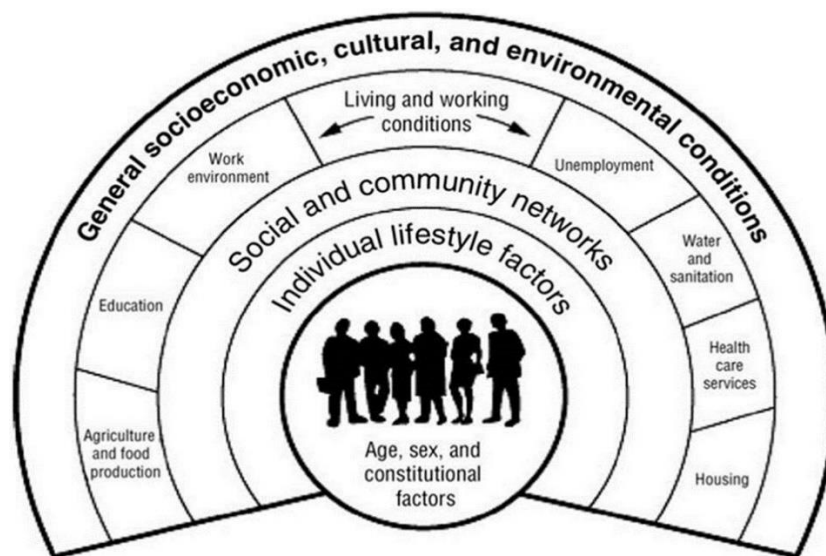
Development of a thematic framework was an iterative process and several frameworks were generated. These were discussed among the expert group and amended following dual review of the transcripts. The initial framework is illustrated (**Additional File Table 11**).

**Additional File Table 11:** Initial thematic framework

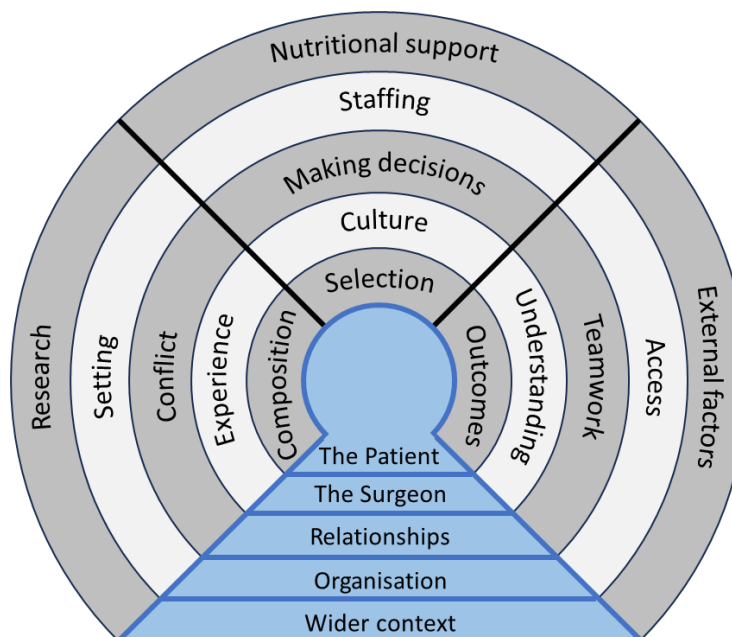
| Theme                             | Subtheme                | Sub-subthemes                       |
|-----------------------------------|-------------------------|-------------------------------------|
| The Surgeon                       | <i>Culture</i>          | The nature of surgeons              |
|                                   |                         | Tradition                           |
|                                   | <i>Experience</i>       | What I've been taught               |
|                                   |                         | What I've done in the past          |
|                                   |                         | What is in front of me now          |
|                                   | <i>Understanding</i>    | Awareness                           |
|                                   |                         | Knowledge                           |
|                                   |                         | Bridging the Gaps                   |
| The Patient                       | <i>Selection</i>        | History                             |
|                                   |                         | Diagnosis                           |
|                                   |                         | Operative considerations            |
|                                   | <i>Composition</i>      | Anthropometric                      |
|                                   |                         | Biochemical                         |
|                                   |                         | Functional                          |
|                                   |                         | Clinical progress                   |
|                                   | <i>Outcomes</i>         | To join or not to join              |
|                                   |                         | Other surgical outcomes             |
| Relationships and decision making | <i>Teamwork</i>         | Seeking advice                      |
|                                   |                         | Collaboration                       |
|                                   | <i>Conflict</i>         | Disagreements                       |
|                                   |                         | Repercussions                       |
|                                   | <i>Making decisions</i> | Ownership                           |
|                                   |                         | Prioritising                        |
|                                   |                         | Planning ahead                      |
| Processes                         | <i>Initiation</i>       | Screening and referrals             |
|                                   |                         | Pathways                            |
|                                   | <i>Timing</i>           | When to identify malnutrition       |
|                                   |                         | When to provide nutritional support |
|                                   |                         | 'Weekend effect'                    |
| Organisation                      | <i>Staffing</i>         | Who makes up the NST                |
|                                   |                         | Shortages                           |
|                                   |                         | Inexperience                        |
|                                   | <i>Access</i>           | Line services                       |
|                                   | <i>Hospital setting</i> | IFU vs non-IFU                      |
| Wider context                     | <i>Awareness</i>        | Importance of nutritional support   |
|                                   |                         | Benefits/ risks                     |
|                                   | <i>Research</i>         | Need for evidence                   |
|                                   |                         | Need for standards                  |
|                                   | <i>External factors</i> | National perspectives               |
|                                   |                         | Global outlook                      |

After the first three interviews, data was coded and explored to understand the types of themes and subthemes emerging. The data appeared to align with two existing frameworks/ models. The first is the 'Social Determinants of Health' model(370,371) (**Additional File Figure 6**). This places personal characteristics at the core of the model, widening to lifestyle factors social and community networks, living and working conditions and finally general socioeconomic conditions. However, this model placed the patient at the heart of the model. Ordinarily, this is the case for delivery of healthcare, but this qualitative study focussed on how and why surgeons identify malnutrition. As such, the model did not fit completely and was not accepted.

**A**



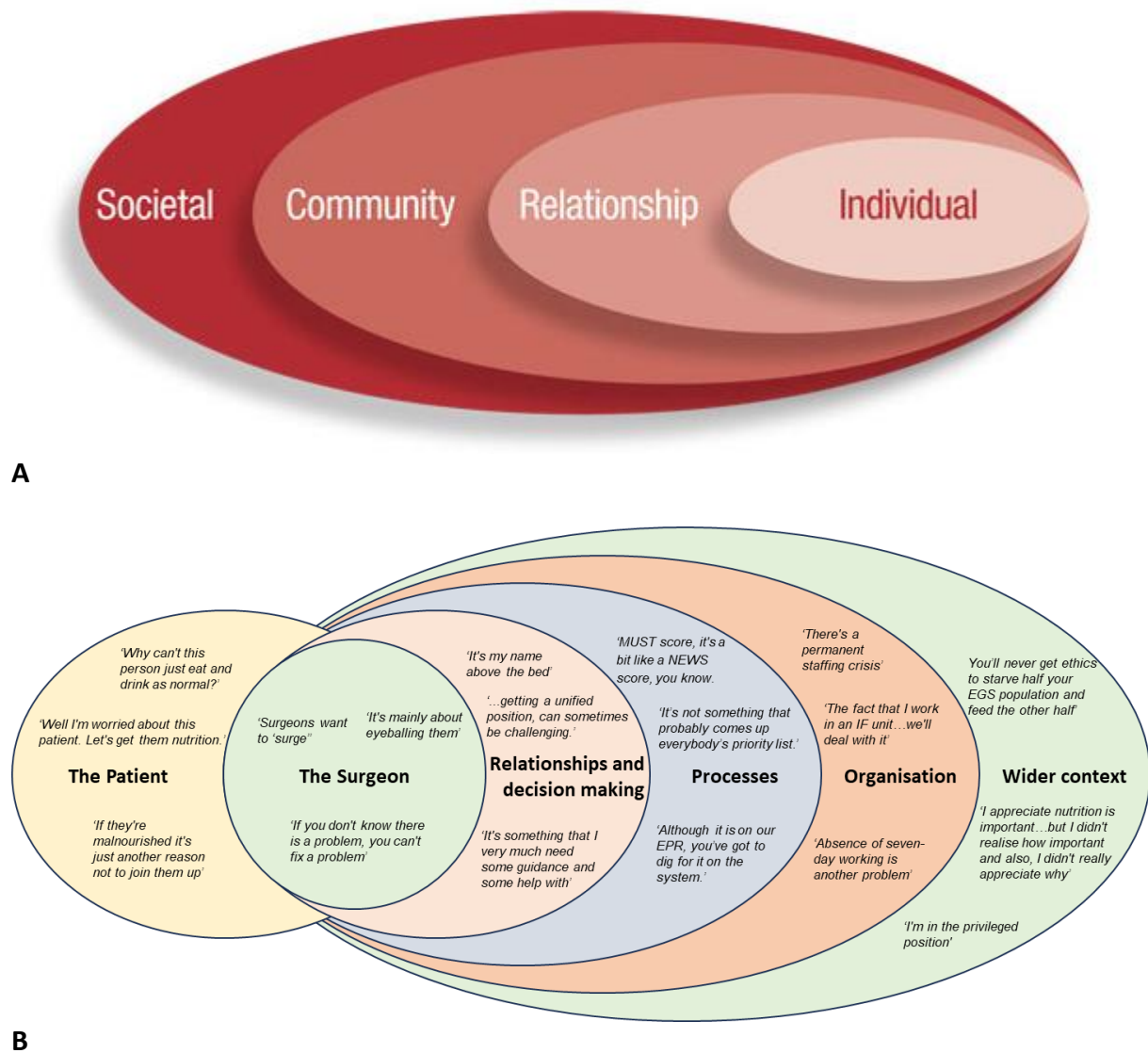
**B**



**Additional File Figure 6:** The 'Social Determinants of Health' model (A) versus the initial thematic framework (B).



The second framework/ model the data appeared to align with is the 'Social Ecological Model of Health'(372) (**Additional File Figure 7**). This model uses different 'levels' to account for the factors affecting health based on social ecological theory. These levels are the individual, relationships, community and societal. These levels align with the many of the emerging themes demonstrated in the initial framework; surgeons could be sited at the first level. However, in this model only the surgeons affect the patient, and this was not true from the data.



**Additional File Figure 7:** The 'Social Ecological Model of Health' (A) versus the initial thematic framework (B).

## Additional File 11: Additional results for Paper 3

### How surgeons identify malnutrition

#### The Surgeon

Three subordinate themes were identified which related to The Surgeon. These were knowledge, experience and planning ahead.

#### Knowledge

Surgeons repeatedly acknowledged that training in nutrition is sparse or non-existent. This was occasionally linked to a particular albumin level which would indicate when one would consider a patient to be malnourished, not perform an anastomosis, or even not operate.

*'I'm not sure it's taught particularly well or I've ever had any sort of formal training in assessing someone's nutrition status.'* **P4 (TH)**

*'I think it might be somewhere from medical school time when it was indoctrinated somewhere, 'Don't operate on people with whom albumin is less than 20 or 25.' You just don't touch them.'* **P7 (TH)**

#### Experience

Past successes and failures are enshrined by surgeons who feel regret. The ability of surgeons to learn from outcomes, especially negative ones, leads to the development of a surgeon's experience, and the same is true for outcomes of malnourished patients.

*'I had one where I probably, well regretted, anastomosing her because she leaked after a right hemi. It could have been multifactorial...it could have been a variety of comorbidities, but [she] was nutritionally poor.'* **P10 (TH)**

It seems this experience is based on the physical appearance of patients. This can clearly lead to the subjective interpretation of what undernourished and well-nourished patients look like. Many surgeons used terminology such as 'the end of the bed' test, and may be akin to physicians equivalent of whether a patient 'looks unwell'.

*'It's mainly about eyeballing them.'* **P1 (TH)**

*'You've gotta be a bit careful with suntans and makeup but you get an idea of someone's nutritional status by looking at them.'* **P18 (DGH)**

### **Planning ahead**

Many surgeons explained that a nutritional plan can be difficult to determine pre-operatively, and can often depend on what is found intra-operatively, and what surgery is performed.

*'I don't think you can really predict it.'* **P10 (TH)**

*'...what you're gonna do is you're gonna write down in your operation note, or at least I do, what my nutritional strategy is going to be for that individual patient tailored to what they've had done, what I think their nutritional risk were beforehand, mostly made up off a fag packet, and with the view to, you know, optimising their recovery.'* **P6 (TH)**

On a number of occasions, IFU surgeons talked about a likely path that a patient is taking or going to take, and that this is relatively straight forward to deduce based on oral intake post-operatively.

*'I think it's common sense to us, whether it's common sense to everybody? But I think it is. Are they eating? No. When did they last eat? It was a week ago. Right, they've been picking for a week. When are they likely to go from picking to eating and get all their calories? If it's not anytime soon based on this trajectory, we will get them some TPN.'* **P14 (IFU)**

## The Patient

Four subordinate themes were identified which related to The Patient. These were selection, composition, clinical progress and operative considerations.

### Selection

There are a number of methods surgeons use to appropriately select patients who may benefit from nutritional support. This includes screening tools, namely the Malnutrition Universal Screening Tool (MUST), and a thorough history focusing on oral intake, weight loss and functional baseline. Many surgeons acknowledged MUST existed, but did not use it, did not find it useful, did not consider it within a 'doctor's' role, did not see its value in the acute setting as it is not validated in this group, or did not think it would change clinical management.

*'I know it gets measured but I don't know what it is [laughing]. It's not something I look at. I know the dietitians measure it and as long as they're acting on it, that's what's important I think. P2 (TH)*

*'But I think the MUST score's probably of limited use...I don't know of a robust validated scoring system for nutrition in the acute setting.' P6 (TH)*

The number of days patients had been without oral intake was important, but the specific length of time at which point to refer for nutritional support was very variable.

*'For me, the history is three days and more patients not being fed with features of vomiting, diarrhoea, small bowel obstruction with peritonitis. These patients I immediately ask them to be post-op put on TPN.' P15 (DGH)*

*'Why can't this person just eat and drink as normal?' P18 (DGH)*

Similarly, surgeons more often used percentage weight loss as an important feature of possibly needing nutritional support, but what the 'cut off' is was variable. The acute presentation of patients made mapping changes in weight loss over time difficult.

*'Somebody who's 20 stone but has managed to lose three stone, very rapidly, is almost more concerning sometimes than somebody who's at the lower end and who's only lost a couple of pounds.' P3 (DGH)*

A patient's function was linked to their degree of frailty, and subsequently their likelihood of a positive surgical outcome. But distinguishing frailty from malnutrition is difficult as it was recognised they are often intrinsically interlinked.

*'[Whether malnutrition can be separated from frailty] I think post-operatively I definitely think of it as a different entity to frailty. I think pre-operatively, especially in the emergency setting, it is part of the same thing.'* **P13 (DGH)**

### **Composition**

In combination with a patient's weight, surgeons used body mass index (BMI) as well to determine whether they are malnourished. A number of surgeons recognised that malnutrition in overweight and obese patients exists, although some, including those at an IFU, found it hard to differentiate.

*'So, the idea of the very, very overweight, but also malnourished patients, which I know is an absolute fundamental of dietitian practice and all the rest of it, I would say I'm not a massive believer in.'* **P5 (TH)**

Whilst a range of biochemical markers were highlighted by a few surgeons, albumin was referenced by almost all surgeons. Many identified that it is not a marker of nutrition and can be related to sepsis and inflammation, and as such, it can not be used in the emergency setting. However, its 'objectivity' appeals to some surgeons.

*'My personal level that I use a lot is albumin, just as simple as that. It's all on a blood test and you can fairly quickly see if there is a problem or not.'* **P7 (TH)**

### **Clinical progress**

The pace of a patient's recovery in the post-operative period was an indicator surgeons use to guide whether nutritional support would be beneficial. This relied on the subjective interpretation of whether sufficient progress was being made.

*'Is the patient still in ileus you know? Are things settling down? That sort of thing as a guide to the longevity of pathology, with a view to then guiding their nutrition.'* **P4 (TH)**

### **Operative considerations**

There was an understanding that there may be no choice but to operate on malnourished patients in an emergency situation, albeit risky. If at all possible, it was considered that delaying an operation may lead to better patient outcomes but this was also not a guarantee, and sometimes a difficult decision to make.

*'What are the consequences of not operating because it's not a zero-sum game.'* **P17 (IFU)**

## The Institution

The Institution has two subthemes: 'collaboration' and 'extended surgical team'.

### Collaboration

Many surgeons discussed the relationship they have with other team members when identifying malnutrition or managing a patient's nutritional support. This was often positive and in recognition of the expertise these wider team members offer, and the educational opportunities they bring.

*'I think you've got to trust others – their expertise.'* **P6 (TH)**

*'So the nutrition team help us by sort of, it's like educating us, you know? It's...I think gone are the days where you can say, 'The albumin is 16 therefore that means...' because it doesn't...'* **P9 (TH)**

### Extended surgical team

As well as surgeons recognising the importance of relationships with individual team members, they recognised they do not work in silos. Delivering nutritional support can be complex, involving many and varied teams – the 'nutritional support team', the 'TPN team', the 'line service team', the 'prehab team' – often in a multi-disciplinary team approach.

*'I think we've got very good dietitian services for the ward...it's got an intestinal failure MDT that meets once a week to discuss the patients on TPN.'* **P2 (TH)**

It was acknowledged by an IFU surgeon that the support differed for those patients on the unit versus those patients on a standard ward.

*'Because we're an IF unit, nutrition support is split into two. So we've got the specialist team that are involved with intestinal failure patients who are mainly on the unit...but we recognised that the patients on the surgical ward who were not under the intestinal failure team got a pretty, you know, second class service.'* **P11 (IFU)**

## Decision making

An emergent over-arching theme was 'Decision making'. This in itself had two themes, 'To join or not to join' and 'Nutritional support'.

### To join or not to join

In the malnourished EGS patient, performing an anastomosis or bringing out a stoma was a multifaceted and complex decision for surgeons to make. Surgeons repeatedly discussed the need for an individualised approach.

### Risk taking

Whilst surgeons recognised malnutrition is not the only reason not to perform an anastomosis, it was an additional consideration. Two surgeons explained there has been a general lean towards a more conservative, risk-averse approach and as such a greater likelihood stomas are formed.

*'If they're malnourished it's just another reason not to join them up.'* **P13 (DGH)**

### Site of anastomosis

The distinction between the risk of an anastomosis and the risks of forming a proximal stoma and its knock-on nutritional effects, particularly in the elderly population, was a key consideration surgeons felt they had to balance. This decision was influenced by the ability of their service to provide nutritional support, as alluded to earlier.

*'Somebody who is malnourished with albumin in their boots, I'm less likely to do certain anastomoses.'*  
**P7 (TH)**



## Nutritional support

The optimal timing to provide nutritional support – pre- or post-operatively – and how this was achieved was discussed by surgeons.

### Timing

The timing of when to start nutritional support depended on the patient's diagnosis and whether it was an acute or subacute problem. It also depended on whether there was time pre-operatively to 'make a difference'. Example diagnoses surgeons used where nutritional support may be considered for a period of time pre-operatively was in patients with inflammatory bowel disease or small bowel obstruction without concern for ischaemia. This was in comparison to patients that have peritonitis where there is no time and it would not make any positive differences to patient outcomes.

*'They tend to have a slightly smoother course, I think, if they're in a better shape beforehand.'* **P10 (TH)**

### Delivery pathways

There were many routes to referral for nutritional support, but very few surgeons described a pathway that was automatic or routine except for those patients referred by the nursing team based on high MUST scores. One surgeon described the potential benefits of having a referral pathway in the EGS setting for nutritional support, akin to the early recovery after surgery (ERAS) programs that are common to elective general surgery.

*'It's very much, you know, if you want someone on TPN, you say, 'Put them on TPN.'* **P4 (TH)**

## Supplementary tables for Paper 3

**Table S25:** Illustrative quotes related to how surgeons identify malnutrition

| Theme and subtheme                                                                                                                                                                  | Supporting quotations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| <b>The Surgeon</b>                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Knowledge</b><br><br><i>'I'm not sure it's taught particularly well or I've ever had any sort of formal training in assessing someone's nutrition status.'</i><br><b>P4 (TH)</b> | <p><b>P2 (TH):</b> 'So you know, the eating thing. That actually came from a conversation I had with [researcher's name] about the NASBO study.'</p> <p><b>P3 (DGH):</b> 'Just in my training really. I can't remember any particular reference to anything like that. I'm sure there has been something I've read somewhere, but it's one of those things, you know, having an albumin below 30 is not good for doing anastomoses and stuff like that.'</p> <p><b>P3 (DGH):</b> 'I think I would need to know exactly how it all relates. And, is grip strength...because I hear it, it's just not something I've ever actually sat and read about.'</p> <p><b>P7 (TH):</b> 'I think it might be somewhere from medical school time when it was indoctrinated somewhere, 'Don't operate on people with whom albumin is less than 20 or 25.' You just don't touch them.'</p> <p><b>P11 (IFU):</b> 'So I mean I can ask for the more fancy things like, you know, like I were teams do triceps and biceps, you know, thickness and skin fold thickness. But in all honesty, you know, I wouldn't look at that myself. I would ask if we can have a proper dietetic assessment...So our dieticians for the intestinal failure patients, they use that and for, and if you ask for a detailed dietetic assessment on the ward, they would do that and they do grip strength and other sort of factors. But it's more, it's really more for the very complex IF patients.'</p> <p><b>P11 (IFU):</b> '[assessing muscle mass via imaging in EGS] No, not routinely. I mean, you know, I am aware of it but I don't. I think there's two reasons. I mean, one is it's time consuming, isn't it? And secondly, we don't have volume assessment on our CTs. You can't look at, you know, a shaded area and assess the volume of something. Yeah, so it's really not practical on a day-to-day basis.'</p> <p><b>P13 (DGH):</b> 'And I know that there are you can do, you know, the various ratios and impedance and what have you? But I'm not, I don't think it ever really enters my...I'm aware of it obviously, but I'm not. It doesn't enter my sort of clinical ward round language.'</p> <p><b>P14 (IFU):</b> 'So there probably is something somewhere. It's just something that's been, for me, it's just been something that's been fettled into my training and certainly since I've been a consultant, that's a number we work with here. Once you lose 10% of your body weight we tend to get a bit twitchy.'</p> <p><b>P14 (IFU):</b> 'Not that we use, no. As I said, you know, dietitians will use all the...you know, I'm sure they use MUST and a few other things. Occasionally, we'll get...a dietitian will highlight to us certain things they're concerned about but it's rare that we wouldn't have picked up on it ourselves.'</p> <p><b>P18 (DGH):</b> 'When we're looking at CT scans and stuff, you know, if you've got a 50 year old bloke, who should have good psoas diameters [mimics this using his hands] and you're seeing someone who is sarcopenic with poor muscle mass, it's clear that they are using up their...they should have more than that, and they're using it up because they've been ill for a while. These are all late signs though, aren't they? They're not particularly helpful.'</p> |
| <b>Experience</b><br><br><i>'It's mainly about eyeballing them.'</i><br><b>P1 (TH)</b>                                                                                              | <p><b>Past experience</b></p> <p><b>P4 (TH):</b> 'And the dietitians have picked up that you know she's lost 14% of her body weight and probably needs feeding. But, you know, again, does she need feeding or does she need an operation?'</p> <p><b>P6 (TH):</b> 'I think you get a flavour of some patients who you know, nutrition is probably not an issue. You know, your fit, young, 20 year old who's got a band adhesion or something, you're probably not gonna focus too long on that but you know, your 70 year old who's he looks like she's about eight stone you who looks got an advance malignancy, then that's different.'</p> <p><b>P10 (TH):</b> 'I had one where I probably, well regretted, anastomosing her because she leaked after a right hemi. It could have been multifactorial...it could have been a variety of comorbidities, but [she] was nutritionally poor. Elderly, decision was not to give a stoma because being an older person managing an ileostomy can be challenging but with hindsight perhaps would have been better off taking that risk than the risk of anastomotic leak.'</p> <p><b>P15 (DGH):</b> '[operating on a man with an obstructed parastomal hernia] It's nothing pleasant to operate, let's put him on TPN and wait...So I decided after week I will operate. I operated on him and luckily, luckily, luckily, successfully...the patient healed, his life is completely changed. And I believe without this step [the TPN], I wouldn't achieve this outcome.'</p> <p><b>P16 (IFU):</b> 'As an IF surgeon I get quite a lot of referrals from other hospitals where you can</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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| <p><b>Planning ahead</b></p> <p>'I don't think you can really predict it.' <b>P10 (TH)</b></p>        | <p>sometimes identify, and it's always difficult – it's always easy to look back once you know the outcome of the patient – and identify those things where you think you could have done better.'</p> <p><b>How do my experience shape the current assessment?</b></p> <p><b>P8 (TH):</b> 'Yeah, so I mean it's just some of it is slightly, I mean it's all quite subjective isn't it? But, but some of it's just how they're looking at the end of the bed. Do they, do they look malnourished?'</p> <p><b>P11 (IFU):</b> 'And appearance, you know that if I think that they've lost some weight and they look cachectic and so on. I mean it's more difficult, isn't it? It's a bit more [licks finger and puts it up in the air]. But I do try and make an assessment of that in order to try and again pre-empt sort of perioperative problems.'</p> <p><b>P18 (DGH):</b> 'You've gotta be a bit careful with suntans and makeup but you get an idea of someone's nutritional status by looking at them...But you're asking me how I assess nutrition in a patient and I go, 'Well I don't.' I guess, at the end of the bed, which is not particularly a great standard of care, is it?'</p> <p><b>P18 (DGH):</b> 'You can be obese and be very...relatively malnourished. And you can be relatively skinny and be well nourished or...so you know. Yeah, so it's trickier than just seeing if someone's skinny or not, isn't it?'</p> <p><b>P1 (TH):</b> 'Interestingly, I don't think it's in the standard NELA risk score. I don't think they ask about any sort of nutritional factors in that. I think they assess albumin but that's more as an acute phase response rather than any nutritional reason.'</p> <p><b>P6 (TH):</b> 'I think that the indications for TPN are pretty niche in the emergency setting...I think, I think if I know what operation I'm gonna do, I can plan. But in a lot of occasions you're not sure exactly what you're gonna do, whether you're gonna do an anastomosis or a stoma or what you're gonna find. So in those cases, wait till you're finished and...what you're gonna do is you're gonna write down in your operation note, or at least I do, what my nutritional strategy is going to be for that individual patient tailored to what they've had done, what I think their nutritional risk were beforehand, mostly made up off a fag packet, and with the view to, you know, optimising their recovery.'</p> <p><b>P10 (TH):</b> 'But I think you can do something relatively small to someone and them have a prolonged ileus. You can do something major and their bowels are going on day two.'</p> <p><b>P11 (IFU):</b> 'You know, the likelihood of requiring short-, medium- or long- term nutritional support, you pretty much know that from a combination of your pre-op assessment, the CT scan that you've got and then, you know what you actually find intraoperatively.'</p> <p><b>P13 (DGH):</b> 'I've got this concept at work that I try to get into my juniors which is variable, of the idea of 'TPN Thursday'. So basically that you make the decision for TPN on Thursday morning because there's no point doing it on Friday. We're not allowed to have TPN over the weekend in our hospital, as in, you can't start new TPN because it has to be an individual bag. There's no sort of premixed bag so if you make a decision on Thursday morning and get a PICC line in, you can start it on Friday and you're done. If you make it on Friday, they're not getting it until Monday. So conceptually that's what I try and do.'</p> <p><b>P14 (IFU):</b> 'I think it's common sense to us, whether it's common sense to everybody? But I think it is. Are they eating? No. When did they last eat? It was a week ago. Right, they've been picking for a week. When are they likely to go from picking to eating and get all their calories? If it's not anytime soon based on this trajectory, we will get them some TPN.'</p> |
| <p><b>The Patient</b></p>                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <p><b>Selection</b></p> <p>'Why can't this person just eat and drink as normal?' <b>P18 (DGH)</b></p> | <p><b>Screening</b></p> <p><b>P1 (TH):</b> 'And then our hospital uses a standard nutritional screening tool. I think it's the MUST score and the nurses do that routinely on emergency admissions, not just NELA patients but for any emergency admission and if the if they get highlighted as being malnourished or potential for malnourished, they get a dietitian review.'</p> <p><b>P2 (TH):</b> 'I know it gets measured but I don't know what it is [laughing]. It's not something I look at. I know the dietitians measure it and as long as they're acting on it, that's what's important I think.'</p> <p><b>P6 (TH):</b> 'But I think the MUST score's probably of limited use...I don't know of a robust validated scoring system for nutrition in the acute setting.'</p> <p><b>P9 (TH):</b> 'MUST score, it's a bit like a NEWS score, you know. It's something that the juniors, and I'll accept responsibility, just don't see it as a doctor's job to do. It's not the doctor's role at the moment to get that done.'</p> <p><b>P10 (TH):</b> '[Whether a high MUST score changes patient management] To be quite honest with you, I don't know because I've never really looked at it.'</p> <p><b>P11 (IFU):</b> '...if I'm made aware that the MUST score is high risk for malnutrition etc then obviously I would take that into account. But I think I'd probably have worked that out for myself to be honest.'</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

**P12 (TH):** 'And then if they're not [resumed normal oral intake], then generally we'd refer them onto the dietitians for supplementation no matter what I suppose their formal MUST score would be.'

**P12 (TH):** 'I suppose I can't remember a time ever when I have been informed of a high MUST score when it hasn't already been someone that's been referred to dietetics or whatever.'

**P13 (DGH):** 'I mean I don't think I particularly use the MUST score apart from just because we talk about it in lectures and what have you?...I guess that I'm expecting someone else to have thought about that, to be honest. And I'm still obviously...the MUST score, the nice thing about it is that it's very sensitive, isn't it in terms of it picks up a lot of people who might be at risk?'

**P14 (IFU):** 'I think it's more a NEWS score for dietetics, isn't it? It draws your attention that there may be a problem. But I think with EGS ones, the problem is always, the presentation of the pathology. In reality wise, it's good to know, but actually if they've got peritonitis, perforation, or some sepsis that needs controlling, you're heading down a particular path come hell or high water...I think it's probably not as good in our acute patient group as a tool I think because it only highlights what you should already be thinking about and looking at.'

**P18 (DGH):** 'I think the problem is the tools we use to screen malnutrition have not been based on a cohort of patients we currently use them on. I mean a MUST score, which seems to be the commonest used one and the one I would reference, that has nothing to do with urgent loss of muscle mass due to a catabolic process in emergency surgery patients at all.'

**P18 (DGH):** 'So we have all these things that are mandated like MUST screening and baseline tools, but as you'll realise they don't actually do anything because someone just does them and then, you know, no one's ever told me a MUST score in their life. There's no formal process.'

#### **Oral intake**

**P2 (TH):** 'I guess the things that I would look at is how long that they haven't been eating for...if they're, if it's getting beyond five days, then I start thinking of what are we going to do in terms of their nutrition.'

**P12 (TH):** 'In my mind, it's a referral for TPN if they're beyond seven days without oral intake. That's my normal sort of denominator...no matter what I suppose their formal MUST score would be.'

**P14 (IFU):** 'Like I say, for the emergency ones if we think that probably it's been a week, which is probably about a number to pick for, once we're looking at a week out, we would be starting some TPN and we're aware that that's the pre-op stuff as well.'

**P15 (DGH):** 'For me, the history is three days and more patients not being fed with features of vomiting, diarrhoea, small bowel obstruction with peritonitis. These patients I immediately ask them to be post-op put on TPN.'

#### **Weight loss**

**P3 (DGH):** 'Somebody who's 20 stone but has managed to lose three stone, very rapidly, is almost more concerning sometimes than somebody who's at the lower end and who's only lost a couple of pounds.'

**P4 (TH):** 'We would tend to ask about weight loss and try and map that against sort of percentage weight loss, kind of how much have they lost over a period of time, if indeed they have. [When asked about how and why they ask about weight loss as part of their assessment of nutritional status] You're about to expose my lack of any suitable knowledge.'

**P6 (TH):** 'I think weight, and then you've got to take into consideration the patient's, you know, what's their pre-morbid state is? Is this somebody who's in their 80 who he sits on the couch all day? You know, what, what are you looking to achieve?'

**P13 (DGH):** 'So in EGS setting, I think that what you're concerned about is that, obviously you tend to operate on them and you're gonna make them more malnourished post-operatively. So any significant weight loss noticeable by the patient tends to be something that should come up in the history.'

**P14 (IFU):** 'For me personally, and my colleagues that also work in the IFU, I think we see it, we see it very differently. We're more attuned to malnutrition than most. Things that interest us, there's a magical number of 10%. If you've lost 10% of your body weight in the preceeding [three months], we'll start to get a bit twitchy about that as that's a proper sign you're losing ground.'

**P17 (IFU):** 'I don't think you can be that precise as to the amount of weight loss. But I think you have to get a subjective assessment from the patient of the degree of weight loss. But you know, I'd be...anything more than a couple of Kgs, I would be concerned of.'

**P18 (DGH):** 'It's about relative weight loss and you know, if you are 30 stone and you lost five stone, you'll still look fat but you've just lost a sixth of your body weight.'



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| <p>nutrition.' <b>P8 (TH)</b></p> <p><b>Operative considerations</b></p> <p>'What are the consequences of not operating because it's not a zero-sum game.'</p> <p><b>P17 (IFU)</b></p> | <p>had an operation or when they come in, or if they're failing to progress you get the nutrition team to see them afterwards with a view to starting.'</p> <p><b>P5 (TH):</b> 'So for the pancreatitics, that if they're otherwise young and fit enough to have their gallbag out, then if their BMI is more than 40, we will keep them in...for the, you know, the cholecystitis, we will tell them you're too big to have an operation and off you go and we'll see back once you've kind of got your BMI down to about 35.'</p> <p><b>P11 (IFU):</b> 'And often that desire to get someone to an operating theatre needs to be tempered by the fact that actually if they waited, and it would be safe to do so, they might actually make that patient significantly better before they take them to theatre or before they do something that is irreversible.'</p> <p><b>P13 (DGH):</b> 'The chronically malnourished, obviously that has a difference, for example, in how aggressively you might pursue conservative management in someone with small bowel obstruction...you might give them an extra 24 hours or so to sort themselves out...because you'll just end up with a small bowel resection and many more chances of it all going wrong.'</p> <p><b>P14 (IFU):</b> 'I think it's something to be aware of, but not something that should be changing too much in decision making. I really think it would be unusual to change a path based on a perceived nutrition issue. If you're malnourished, coming into an EGS operation then your pathology is probably pretty bad, whatever that is...I think the inability to be 100% sure whether someone's malnourished or not, in isolation, probably wouldn't make a huge difference.'</p> <p><b>P14 (IFU):</b> 'Yeah, but the devil's in the detail isn't it?'</p> <p><b>P15 (DGH):</b> 'I don't get involved directly in nutrition unless you find the patient with the high score of the NELA, and we go back and we find that they are malnourished. And if we find that, it will be always a discussion with anaesthetist, whether we should go ahead because we would predict poor outcome. And we would put it down to the patient and their families. What are the risks? Whether we should operate or we should not operate? Whether it can wait until nutrition is improved, or keep them comfortable in fact.'</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p><b>The Institution</b></p>                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <p><b>Collaboration</b></p> <p>'It's something that I very much need some guidance and some help with.'</p> <p><b>P10 (TH)</b></p>                                                     | <p><b>Seeking advice</b></p> <p><b>P2 (TH):</b> 'The specialist nurse that we've got with us. She often kind of mentions it, she drives it all. 'That patient hasn't eaten for a week now'. She keeps on, you know, she keeps a tab of how long it's been before the patient's not eating.'</p> <p><b>P9 (TH):</b> 'So the nutrition team help us by sort of, it's like educating us, you know? It's...I think gone are the days where you can say, 'The albumin is 16 therefore that means...' because it doesn't...'</p> <p><b>P10 (TH):</b> 'And you can refer to them early. It doesn't necessarily have to be, 'This patient needs TPN.' It's, 'What do you think?' It's much more collaborative and in many ways, it's easier to get someone established on TPN now because there's a team there to help do that and help manage it.'</p> <p><b>P12 (TH):</b> 'Well, I actually say that [nutrition is 'non-surgical'] as a good thing in that I think dietitians are better at it than us. I think we can probably give outlook in terms of when someone's gut will start functioning again but in terms of what's best for them at a moment in time given that information, I think the surgical dietitian is better at it than we are, probably. So I think we should acknowledge that and instead of playing ourselves, probably utilise them a bit better.'</p> <p><b>P16 (IFU):</b> 'So I've got multiple dietitians who shout out, who bewail the fact that surgeons are very bad at getting nutrition input sooner rather than later in an EGS setting. So I'm scared to death of them so I'll do what they say!'</p> <p><b>P18 (DGH):</b> 'But most the time I value their opinion. Now I'm talking 98% of the time, I'll listen to what they've got to say because they are invested, high-functioning, critical individuals that do things much better than I could.'</p> <p><b>Collaboration</b></p> <p><b>P6 (TH):</b> 'I think you've got to trust others – their expertise. I quite often defer to dietitians, GI dietitians. I think it's tempting to undervalue the experience and the expertise of people we work with and I always try not to do that and I'm quite happy to defer to them. They say, 'No [first name of surgeon], that's bollocks. You know, this is what I think we should do.' That's fine. We'll go along with that. You know, we're mature enough to revise that next week if necessary or stick with it. I think it's part of teamworking, isn't it?'</p> <p><b>P9 (TH):</b> 'They're proactive, intelligent, just incredibly social so that you never feel that they're forcing anything on you. They're receptive to ideas. Over the last 10 years, especially over the last four or five years, we've really sort of just become a whole team. Everybody now knows their roles.'</p> <p><b>P14 (IFU):</b> '[With reference to a colleague] He's the robotic cancer surgeon, and because he</p> |

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| <p><b>Extended surgical team</b></p> <p>'I think we colloquially refer to them as the TPN team.' <b>P3 (DGH)</b></p> | <p>doesn't work within intestinal failure, and he doesn't work within IBD and gastro, he actually finds it much more difficult than I do to access these services for these patients...he just doesn't have a day-to-day working relationship with them and sharing patients with them all the time. ...Yeah, he knows, he knows the guys and you know, he just doesn't have a day-to-day working relationship with them and sharing patients with them all the time. So when he's on, if he's on call, if he gets EGS patients and they need nutritional support, he just finds it a little bit harder to hammer those nails down than I and my colleagues who work on that side do. It's all about relationships.'</p> <p><b>P18 (DGH):</b> 'If we ran this as a business, where you and I were setting up EmergencyGeneralSurgeryCare.com with a big building in, I don't know, let's say the middle of Sheffield, you wouldn't leave it to a junior doctor or a routine nurse to assess whether they've got nutritional needs or not, would you? You'd employ someone to come round...and recommend nutritional plans for them accordingly, and discuss it with me or, you know, someone in charge of their care.'</p> <p><b>P18 (DGH):</b> 'And I'd love to see and a proper post take ward round where you would have a dietitian, wouldn't you? You'd have loads of people that aren't there at the moment.'</p> <p><b>Shared decision making</b></p> <p><b>P2 (TH):</b> 'I think we've got very good dietitian services for the ward...it's got an intestinal failure MDT that meets once a week to discuss the patients on TPN.'</p> <p><b>P4 (TH):</b> 'There's a nutritional MDT that looks at all of the inpatient TPN patients and will feedback</p> <p><b>Nutritional Support Teams</b></p> <p><b>P1 (TH):</b> 'So there's some there's a Specialist Nutrition Team that offer their team of gastroenterologists, specialist nurses, dietitian who offer specialist intestinal failure advice for TPN and advanced nutrition.'</p> <p><b>P2 (TH):</b> 'There's some colorectal surgeons, gastroenterologists and a CNS, and dietitians.'</p> <p><b>P8 (TH):</b> 'So that's led by one of the gastroenterologists and then it's obviously got the other components that you would need so specialist nurses, dietitians, pharmacists etc.'</p> <p><b>P11 (IFU):</b> 'Because we're an IF unit, nutrition support is split into two. So we've got the specialist team that are involved with intestinal failure patients who are mainly on the unit...but then we recognised, I mean, before the pandemic, actually, we recognised that the patients on the surgical ward who were not under the intestinal failure team got a pretty, you know, second class service.'</p> <p><b>P13 (DGH):</b> 'Yeah, not necessarily because they want to do it, but because, well basically...we have an upper GI consultant who has an interest in bariatrics who's PhD was in a lot of nutritional stuff and we've just kind of foisted it, right?'</p> <p><b>P17 (IFU):</b> 'So the intestinal rehab service is serviced by three consultant surgeons, three focussed gastroenterologists with a focus on intestinal rehab, but then there's a nutrition gastroenterologist that also supports those. And I think there's about five of them. So there's about 8 gastroenterologists in total. There's dietitians, psychologists, physiotherapy and also we have a Prehabilitation Service for patients having complex GI surgery. So that would include all IF patients. And that consists of anaesthetists, physios, dietitians etc.'</p> |
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**Table S26:** Illustrative quotes related to barriers encountered by surgeons

| Theme and subtheme                                                                                                                                                                                                                                                         | Supporting quotations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| <b>The Surgeon</b>                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p><b>Understanding</b></p> <p><i>'I appreciate nutrition is important...but I didn't realise how important and also, I didn't really appreciate why.'</i> <b>P9 (TH)</b></p> <p><i>'If you don't know there is a problem, you can't fix a problem'</i> <b>P7 (TH)</b></p> | <p><b>Importance</b></p> <p><b>P1 (TH):</b> <i>'In fact, it often gets worse, while they're in hospital, particularly on surgical wards where you go through the cycle of nil by mouth for various tests, CT scans, preparing for theatre, after theatre, bowel anastomoses etc. etc. So, you know, the fact that these patients are often malnourished and even get worse in hospital is not a surprise really.'</i></p> <p><b>P4 (TH):</b> <i>'I guess over time it's become much more at the forefront of people in terms of understanding of management and optimising patient care, both kind of operatively and in the post-operative period.'</i></p> <p><b>P8 (TH):</b> <i>'I think people probably are getting better at it than what they used to be but I suspect as you probably gauge from some of the answers I've given you that a lot of it comes down to subjectivity rather than objectivity.'</i></p> <p><b>P12 (TH):</b> <i>'It's just yet another thing that's been focused on within enhanced recovery and things in elective patients, where the emergency care's been a bit left behind is now coming to the forefront.'</i></p> <p><b>Benefits/ risks</b></p> <p><b>P5 (TH):</b> <i>'And the number of line-related sepsis related things that we see is very low. So that actually the downsides are really not there. It's just the cost.'</i></p> <p><b>P6 (TH):</b> <i>'I've learned over the years that if you try and build TPN into EGS, you tend to give a lot of short courses of TPN and I think that's bad...with the risk of central venous feeding. And I don't think nutritionally it's felt to be particularly robust.'</i></p> <p><b>P11 (IFU):</b> <i>'We've got a pretty good system to identify those patients at risk of refeeding.'</i></p> <p><b>P13 (DGH):</b> <i>'I recognise all the complications that come around TPN especially in terms of the infective complications and line sepsis and MRSA and all that. So yeah, I'm not completely blasé to it.'</i></p> <p><b>P14 (IFU):</b> <i>'We like, or I certainly like, the more controllable delivery, you know. You give them a 2000 calorie bag, you know they're gonna get 2,000 calories.'</i></p> <p><b>P18 (DGH):</b> <i>'And then, the other aspect is it's always been so hard to deliver that care. TPN's expensive. It's dangerous. Our nurses don't like it. Patients don't like it. It's a low-grade poison. Knowing when to start. Knowing when to stop. It's a real faff, isn't it? It's too hard to do it and it's too expensive and if you have it for more than two weeks, you've got to fill out another form.'</i></p> <p><b>Awareness</b></p> <p><b>P3 (DGH):</b> <i>'And that sort of, 'Oh yeah suddenly you've gone two or three years through the pandemic and there's a whole load of stuff that's changed, that nobody's really aware of.'</i></p> <p><b>P8 (TH):</b> <i>'We can probably do better and I suspect sometimes we are probably more reactive than proactive, I suspect. I mean, how many times do we get several days down the line when somebody's still in ileus having been obstructed and then you suddenly think, 'Ah maybe, maybe they should have some TPN or something?' And you've often missed a little window where you could have started something a few days sooner.'</i></p> <p><b>P16 (IFU):</b> <i>'...there was this lack of awareness that when they come as an admission, or their index presentation, is not when their symptoms have started. They're already on this kind of decline, so to say nutritionally, which started at least a few days ago.'</i></p> <p><b>P18 (DGH):</b> <i>'We didn't understand and everyone had a less understanding of a broader subject rather than greater understanding of a smaller subject, which is how medicine and surgery's changed over the last 20 years, hasn't it?'</i></p> <p><b>Ignorance</b></p> <p><b>P3 (DGH):</b> <i>'And I think part of it is, is not really knowing what there is out there and what's changing...So I don't think there's any barriers in me making the decision other than my own ignorance.'</i></p> <p><b>P10 (TH):</b> <i>'Before, when they used to say to us, 'Oh, will you prescribe the TPN?' I'd think, 'I have no idea what to prescribe.' And you end up just signing the box that the pharmacist has done.'</i></p> <p><b>P10 (TH):</b> <i>'I don't think that patients have any awareness of malnutrition and what that means and it's just another thing that you can discuss with them as you agree on how you're going to manage them... I don't think...I think they have an awareness of what people consider good and</i></p> |



bad foods. I don't know that they necessarily understand the implications of that for them. Certainly they don't understand the implications of it in the context of emergency surgery because I don't think we understand it that well to be honest.'

**P11 (IFU):** 'There is the fact that other teams deal with it and as I've already said, it's a rarity that our ward round coincides with the Nutritional Support Team ward round. So unless you actually sit there and read what they've said or speak to them directly you're, you know as a junior doctor, you're pretty much unaware of what they've done, how they've come to that conclusion or whatever.'

**P18 (DGH):** 'It's hilarious that I have to prescribe the TPN when my interest and knowledge of that process is minimal compared to theirs [nurses].'

**P18 (DGH):** 'They'll go, 'The albumin's okay. They're not malnourished.' And you just think...you know, you're having an argument with someone about putting in a line or getting them some TPN, and you just think, 'Well, you just don't know what you're talking about.'

#### **Improving understanding**

**P3 (DGH):** 'And I think if there was like a little nutrition teaching package for surgeons, I think that would be really good. Especially relaying that to the emergency side of stuff.'

**P3 (DGH):** 'And if you've got somebody who knows a lot about something that comes to a department, they can take that much further forward, but if you've not got somebody like that who's coming in and bringing the whole load of knowledge from elsewhere, if you've got to identify that there's a problem and then someone needs to go and acquire that knowledge and bring it back or or you don't...'

**P3 (DGH):** 'Having somebody maybe even as a you're the nutritional lead for general surgery, sort of thing. And it's your job to keep your eye on that and update everybody else because I suspect if we're not talking about it, then nobody's really looking for those developments and things like that.'

**P9 (TH):** 'Empowerment. I'll tell you, at Hospital z, it was the empowerment of the surgeon to influence nutrition. Up until that point I'd done all my training in x deanery. And up until that, you dare not, how dare you as a surgeon, even start talking to the nutrition team about nutrition. It was like you know I had absolutely no say in nutrition. And I'd just grown up with that, you know. If I felt that...I'd say, 'Any chance you could have a look?' You wouldn't dare start, or do anything, because it was just viewed as, 'How dare you touch my patient regarding nutrition?'

**P10 (TH):** 'I think there could do with being more surgical representation. I know there is a surgical consultant who is involved but because it's not built into their job plan doesn't participate in the nutrition ward rounds, so sees patients on an ad-hoc basis and contributes significant amount to their care.'

**P11 (IFU):** 'I know there's some stuff in ISCP but it's pretty vague.'

**P11 (IFU):** 'So no, I don't think it's adequate at all but then, you know, it's like so many things isn't it? There's so much you need to know...as I say, there's so many different things to learn about isn't there you know? How do you get good at this kind of stuff, you know?'

**P11 (IFU):** 'I think for a colorectal surgeon particularly, and for UGI surgeons, I think spending some time you know, on that attachment to, you know, attached to the Dietetic Clinic, the Nutrition Support team...whatever would never be a bad thing. But the reality is, you know, how do you mandate that?'

**P12 (TH):** 'So I think training is important but more in terms of recognising who might be slipping under the radar, not necessarily what to give them. Yeah, training in identification, rather than treatment, probably is the best way to summarise it.'

**P14 (IFU):** 'I think education. I think, you know, awareness, things like this. The message being brought from the dietetic world from being something you've never heard about at BAPEN to something you're hearing about at ASGBI and ACPGBI [major UK surgical societies]. I think making people more aware of it I think is what is needed.'

**P14 (IFU):** 'Probably because we don't understand it isn't it [laughs]? We don't! We can see unhealth and think it's skinny people and frailty. But we don't...it's probably a knowledge gap isn't it and that for us is training about nutrition and wound healing and things like that.'

**P15 (DGH):** 'I think like everything in the NHS or in the healthcare should be MDT approach. And even by calling them it's becoming an MDT approach. We put the data, we put our indication, we put our findings to them.'

**P17 (IFU):** 'Emergency surgery has always been something that people do on the side, and doing a combination with their elective. And I think now that you have the rise of emergency surgery as a specialty, it's actually a really exciting opportunity to begin to create standardised systems for these patients like we have in elective settings...because actually they're the group of patients when you have the most potential benefits because they have a high volume of morbidity and therefore you can demonstrate a difference in their care.'

## Culture

'Surgeons want to 'surge'.' P11 (DGH)

**P18 (DGH):** 'We would sit people in bed with tubes, we'd drip...we were talking today, I was talking with one of the senior sisters that works with me about giving people 30s, 60s, 90s and building up over time and five or six days and the famous stories of patients having arguments with consultants about why they were so hungry on day 4 from the consultant not letting them eat. I think we were afraid.'

### Nature of surgeons

**P1 (TH):** 'Yeah, I think surgeons are very difficult to change their opinions.'

**P5 (TH):** 'We have had a registrar and that sort of made that a little bit easier but generally you're kind of stuck with the views of the consultants that you've got, which cannot change that much actually, you know. So you learn new stuff but you're kind of attitudes perhaps don't change that much.'

**P7 (TH):** 'It's the group of people who are becoming a surgeons. We're inpatient. We're generally inpatient.'

**P12 (TH):** 'I think this...nutrition and malnutrition is one of many aspects of care that is kind of 'non-surgical' in that it doesn't involve the operation.'

**P13 (DGH):** 'You still see surgical colleagues sometimes reluctant to use enteral feeding because 'this is a, you know, this is a very dodgy suture line' or 'it's a very difficult anastomosis' and you think well, you know, we're not gonna...we've got litres of fluid going through it anyway. We're not going to alter it by putting in a few more mls through it, sort of thing.'

**P16 (IFU):** 'I think some surgeons, including myself sometimes, feel that the best answer to solving the patient's problem is by doing an operation.'

### Tradition

**P1 (TH):** 'But there's still a lot of dogma in surgery, you know. There's still a lot of old practices, you know.'

**P4 (TH):** 'I can't imagine on the ward round and going, 'Can we test this patient's hand grip strength?' Because people would look at me like I was bonkers.'

**P13 (DGH):** '[On using albumin as a marker of malnutrition] It's sort of an old-fashioned sort of way of talking. It's like an old language, because everyone did believe that albumin was the one and only marker of nutrition.'

**P14 (IFU):** 'So my unit is very internally appointed...and therefore their behaviours and practices all mirror one another.'

**P1 (TH):** 'So if I if I decide somebody needs TPN I have to refer to the nutrition team. I think it's in some ways it takes the pressure of the decision off you a little bit because it's not something I am an expert at by any stretch the imagination and it's something that I very much need some guidance and some help with, and that's what they do really, really well.'

**P6 (TH):** 'Usually in my experience, if I'm the surgeon in charge of their care, they will usually go along with what I say unless they think something's not safe from an airway perspective.'

**P8 (TH):** 'So if I've got a patient that I think needs nutrition, the barriers we come up with are sometimes there can be a delay to assessment and an authorisation...pharmacy will then sometimes recontact the ward and say, 'Well, that's fine. We can issue that. But only once we've had authorisation from the nutrition team.'

**P9 (TH):** '[Gastroenterologists] they used to come along and say, 'This is the nutrition plan.' I'd say, 'I disagree with it so therefore you need to take the patient over.' They would say, 'Well we're not the named consultant therefore, there you go.' I'd go, 'Great. In which case I want TPN.'

**P11 (IFU):** 'You know, if there's nothing surgical to do, the first thing they [intensive care unit] ask is about feeding.'

**P15 (DGH):** 'I think like everything in the NHS or in the healthcare should be MDT approach. And even by calling them it's becoming an MDT approach.'

**P17 (IFU):** 'It's shared decision making between the nutrition team and the surgeon responsible for the patient and often in the emergency setting, the intensivists.'

**P18 (DGH):** 'I mean I think they normally agree with you because you present a cohesive and sensible argument and if they go and see him and say, 'Well I don't think this is right. I think we should do this.' I'll listen to them because they are valued. And if it makes sense I'll listen to them. And if it doesn't, I'll ask them why they think that and if they can't convince me, which is rare, I'll disagree with them and do what I want to do and say, 'Well look, I'm gonna override that because I'm in charge.'...I don't think you [surgeons] can do any of this work. Expecting us to assess and do all this stuff as well as other people is just nuts. I mean, everything is placed upon us as consultants. We seem to be responsible for everything: the performance of everybody, every blood test...everything! It's just old-fashioned thinking.'

## Ownership

'It's my name above the bed' P9 (TH)

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| <p><b>Time constraints</b></p> <p>'We don't have that luxury in emergency surgery. You know, time's limited.' <b>P1 (TH)</b></p> | <p><b>Lack of time</b></p> <p><b>P6 (TH):</b> 'You're relying sometimes on your allied health professionals to come along and your dietitian who's got a bit more time and expertise in using other sources to find out, 'Well, actually this patient said she was okay beforehand and her weight was stable but I've spoken to GP and I've spoken to the daughter and she tells me she's lost, you know, two stone over the past two months.' You know, that adds a different, a whole different layer, to the, to the likely recovery, I think and, and something which, you know, quite frankly, I haven't got time to do.'</p> <p><b>P7 (TH):</b> 'But just because I don't know how to do it properly and I definitely don't have time or willingness even to try to understand or remember those formulas to calculate calorie nutritional support that they need. So, I usually give it to somebody who knows what they doing.'</p> <p><b>P7 (TH):</b> 'It's mainly the timing because when you've got a round of 40 in patients in the morning, quite a lot of them, just because of time pressure, we do that, 'Oh okay, fine. Let's do this x, y, z.'</p> <p><b>P11 (IFU):</b> '[in using CTs to assess for muscle mass] Not really for sarcopenia. No, not routinely. I mean, you know, I am aware of it but I don't. I think there's two reasons. I mean, one is it's time consuming, isn't it?'</p> <p><b>P13 (DGH):</b> 'So most of the problems come from delays in diagnosis or delay in treatment, you know. Your conservative management, which goes on too long. So I don't think malnutrition is necessarily a major issue. I can see it post-operatively obviously it is, but preoperatively, no. I understand the idea that we need to try and optimise our patients better. And certainly that's mostly, you know, electrolyte-based and what have you, but to me that, you know, optimised electrolytes, and those kind of things and fluid shifts, I don't think there's going to be enough time most of the time for nutritional optimisation.'</p> <p><b>P15 (DGH):</b> 'I mean if it is an acute abdomen, most of the acute abdomens we are talking about they should be operated within 12 hours. Yeah? Can you improve the nutrition within 12 hours? Unlikely to make them much fitter.'</p> <p><b>P16 (IFU):</b> 'I think you need to have somebody who knows what they're doing and how to interpret the results and everything. It's more than I think you can ask from any kind of random EGS team out of hours or in hours who are already busy to also do that, because a proper nutritional assessment takes an hour at the very least. And I think you just don't have that.'</p> <p><b>Prioritisation</b></p> <p><b>P6 (TH):</b> 'We've got so many things to focus on – getting your NELA stuff done, working out the risk, whether we should be operating or not, what's a futile laparotomy – you know, all those things, nutrition's probably further down the pecking order at the minute because we know so little about it. But I think it's probably one of the most important things. It's certainly become one of the most important things in elective practice.'</p> <p><b>P6 (TH):</b> 'Because in a resource stretched, workforce stretched environment, you tend to focus on what you think the important things are, don't you? And, you know, if you can't get your patients into theatre in a reasonable time and you know, you've got to do the NELA score, speak to the family...you've got a pecking order of things which you tend to work through. And I think if the impact of poor nutritional management was better known, if there is a significant one – I suspect there will be – and there's some data out there, then I think it would go up people's priorities and people will be more inclined to make time for it.'</p> <p><b>P8 (TH):</b> 'Because I suspect traditionally it's not something that probably comes up everybody's priority list.'</p> |
| <p><b>The Institution</b></p> <p><b>Provision</b></p> <p>'Absence of seven-day working is another problem.' <b>P12 (TH)</b></p>  | <p><b>Adequate access</b></p> <p><b>P3 (DGH):</b> 'Right now we've got control of this. We've got excellent access to, you know, getting PICC lines and stuff put in for people.'</p> <p><b>P4 (TH):</b> 'I think a lot of the kind of traditional barriers that used to be embedded, you know, that kind of belief of you know, additional access, IV access, long-term IV access, those things have gone actually. I think we're pretty good at kind of implementing decisions like that relatively quickly, once they've been made. But you know, a lot of it is just thinking about it, isn't it?'</p> <p><b>P4 (TH):</b> 'I think having a really established setup is really helpful. And certainly, because it's accessible, because it's easy, it certainly encourages you to a A, think about it, and B, you know, perhaps deliver it earlier than perhaps you would have done historically.'</p> <p><b>Inadequate access</b></p> <p><b>P8 (TH):</b> 'A couple of patients where we've drifted into the weekend and I've ended up having to send them down to the CEPD list to get central lines put in because I was just getting fed up of waiting for a PICC line'</p> <p><b>P10 (TH):</b> 'Access to the nutrition team is acceptable. Access for PICC lines is not; that often delays patients. Weekends and bank holidays delay patients because there isn't a service then because</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

it's not funded.'

**P16 (IFU):** 'In most of the NHS, you know, the problem is there's no such thing as a 24/7 dietitian. So especially if somebody comes in on the weekend, let's say someone comes in on the Friday evening, the next time a dietitian could actually assess them isn't until Monday 8am...Part of it falls on NHS infrastructure to make sure that we actually have people who could do that, not necessarily 24/7, but the very least seven days a week.'

**P17 (IFU):** '[IF surgeon reflecting on why was it like trying to 'draw teeth' when not working in an IF unit] Availability of TPN, comfort around it, nursing, logistics of being able to give TPN, being able to manage the lines, recurrent line sepsis, availability of a line service...you know, all these different issues.'

**P18 (DGH):** 'And the problem I don't think is with TPN. The problem is getting a line put in by someone who's prepared to do or can do it, finding that person, getting a funded service and then having the nursing staff to look after it well...But trying to get a line put in to have some TPN is a nightmare.'

#### **Weekend effect**

**P3 (DGH):** 'We've got emergency bags of TPN that we can use and prescribe. So even over the weekend, once we've corrected all the electrolytes up and tried to avoid refeeding, actually, we can go and start people on TPN. And I don't think everybody in the hospital can do that, but we certainly can do that in GI surgery. You know, we're not then necessarily being forced to wait for the dietitians and everybody to come on Monday and then maybe see them Monday afternoon, and order it all up, and it starts Tuesday. If we, Friday night, get somebody who needs some TPN for some reason, they can start it. It won't be bespoke, but it will be, you know, it's almost built up to be safe for refeeding etc. You know, smallish doses, but you can start that process.'

**P5 (TH):** 'So, you know, if you want to start TPN on a Friday, it's always a tricky thing to do. You know, if you hit the morning, that's fine. But certainly once you get, you know, beyond lunchtime on a Friday, you're not gonna get anything kind of manufactured and made and sent up, or, you know, or anything like that.'

**P7 (TH):** '...a lot of things depends on as well which time of the day we are and what day of the week it is because if it's Friday afternoon, you know you're not gonna get anything. It's just because nutritional team is already gone. To get TPN, it's a nightmare. We can generally get emergency ones because we have, every ward has emergency supplies, so we can use that in the worst case scenario.'

**P10 (TH):** 'It probably makes you think about it earlier and in more patients because they don't mind going to see a patient and saying actually, 'I don't think they need it at the moment.' And that's fine. But it means that the ones before where you'd have gone it a week, 'Oh, they've not eaten anything for a week. Oh, it's now Friday of a Bank Holiday weekend. Oh, they're now not gonna have anything for another four days.' Those days have gone, I think.'

**P13 (DGH):** 'I've got this concept at work that I try to get into my juniors which is variable, of the idea of 'TPN Thursday'. So basically that you make the decision for TPN on Thursday morning because there's no point doing it on Friday. We're not allowed to have TPN over the weekend in our hospital, as in, you can't start new TPN because it has to be an individual bag. There's no sort of premixed bag so if you make a decision on Thursday morning and get a PICC line in, you can start it on Friday and you're done. If you make it on Friday, they're not getting it until Monday.'

**P15 (DGH):** 'The worst cases are when they come Friday afternoon. Because you have Saturday and Sunday ahead. And the nutrition team is unlikely to be available. And if it is a Bank Holiday Monday, it's even worse that it can go up to Tuesday. And until they see them on Tuesday, they can't start TPN until Wednesday. Because the PICC line team will not accept the PICC line until the nutrition team agrees they need TPN... So if we miss the window in the morning, the nutrition team doesn't come in the morning and doesn't say yes this patient needs TPN and the PICC line later in the afternoon – one o'clock – 'Oh, we are fully booked now. We will do it tomorrow.' So, we end up going to Wednesday and you almost lose a week... Friday afternoon patients or Friday midday patients, when they come before they can be assessed by the consultant, everyone is slowing down. It's the weekend!'

#### **Electronic systems**

**P3 (DGH):** 'Largely because I think on x software I have no idea where to actually find the MUST score. It's in there somewhere but I have no idea where.'

**P4 (TH):** 'I have to say, I'm a little bit lazy when it comes to it and don't use it very often.'

**P5 (TH):** 'When you go back and look at the data that's in that, it's entirely made up. So you know, it's there but I think because people are not really referring to it, you can't necessarily trust what's in it.'

## Staffing

'There's a permanent staffing crisis.'

**P18 (DGH)**

**P10 (TH):** 'I know that they have a MUST score when they come in but I don't know where to find it on our electronic system so I've never looked at it'

**P11 (IFU):** 'Although it is on our EPR, you've to dig for it on the system.'

### Inadequate staff

**P1 (TH):** 'I think there's not enough dietitians on the ward and I think there's you know, we're strapped service.'

**P3 (DGH):** 'But on other wards where there may be two nurses to 33 patients, you know, they're lucky if they can get some food. We've got to the fairly sad state now, of actually, where the support that sometimes people need in eating, in physically getting the food to their mouths, we seem to struggle to do now because we don't have enough staff to do it.'

**P5 (TH):** 'So, we've got some F1s and F2s but we've got no, sort of, team core trainees or registrars. So yeah, that is a problem for us as well because the expertise that we have is kind of, that's all that we have. Whereas in most firms you've got kind of registrars coming through that have got an interest in this thing where, you know, they tend to sort of drive changes.'

**P7 (TH):** 'It's, it's just mainly restraints on all services because I know the nutritional team is understaffed so they just literally can't be on all wards and everywhere.'

**P8 (TH):** 'As I say, quite often, it tends to be more the interventional radiology service that does it and like anywhere, any other hospital, the interventional radiology service is generally under quite a bit of strain at times.'

**P18 (DGH):** '[Explaining reasons for the lack of a NST in their trust] Well who's going to do it? Who's going to run it? Who's going to pay for it? Who's going to do it when that person is not there? You know, it's all it's all the challenges of being in a small hospital. Do we need one? I don't know. Where's the evidence? Who's done the audit? Who's going to do the business case? Who's interested? We're up to 10 [counting on fingers]! They're all these standard things which you've got to try and...you'll learn when you become a consultant. There are barriers for trying to improve care; it's not just having the idea. And you need something that's fit for purpose for your institution...You have to work with what you've got.'

### Inexperienced staff

**P11 (IFU):** '[In relation to PICC line infections and thromboses] So it's always a bit of a shock when you see that and it turned out that junior doctors were taking blood from the lines and nobody told them that they shouldn't.'

**P13 (DGH):** 'And now, that whole lot of dietitians have all gone and we've got very, it sounds disparaging, but they're all very junior and they actually find it really difficult to get in contact with the consultants and it can be a real problem...I think it's a generational thing.'

### Disagreements

**P1 (TH):** 'Quite rightly our nutrition team don't want to give TPN on everyone. You know, if we can get an enteral route in, that's much preferable. So the usually the scenario is that actually, you know, if they disagree that TPNs needed immediately, they will usually suggest some enteral option that we haven't necessarily thought of.'

**P5 (TH):** 'So I think we would we would ask for it a lot earlier; it's just that they [gastroenterologists] tend to say no if it's not going to be sort of seven days or more.'

**P8 (TH):** 'It's never about do they need something or nothing. A debate you tend to have can be around TPN versus assisted enteral feeding.'

**P9 (TH):** '[Having had discussions about who to refer] And this concept of, 'we need to wait seven days before starting IV nutrition'. I mean, it just doesn't work anymore...we can now turn round to the nutrition team and say, 'This patient is going to get a damage control laparotomy. They are not going to be absorbing feed for at least a week. Therefore, can we start IV nutrition now whilst we're trying to get them into theatre?'

**P9 (TH):** 'So, so I'll tell you, we have had intestinal failure patients who I have totally disagreed with the plan and that's absolutely fine. I've moved the patient to [an IF unit].'

**P10 (TH):** 'And usually the sticking point is they don't understand what the exit strategy is because they don't want to give TPN indefinitely and providing you can give them a very good reason for it, you can often come to an agreement that that's what you're going to do.'

**P13 (DGH):** '...because we're like, 'Look we're...this is what, you know, we're carrying the can for this decision and so if I think they need TPN, ultimately that should be the case, unless you can persuade me that I'm, you know, factually wrong in my assessment of this patient. If it's all just opinion-based then my opinion wins.'

**P13 (DGH):** 'And you know, we will say at the end of an operation, I want the patient to start TPN tomorrow. And they will come around and go, 'I think the patient might start eating soon, and there's no evidence for less than seven days of TPN.'

## Conflict

'...getting a unified position, can sometimes be challenging.'

**P6 (TH)**

## Hospital setting

'The fact that I work in an IF unit...we'll deal with it.' **P16 (IFU)**

**P14 (IFU):** 'So if you take a, you know, a post-op obstruction or something, or just a big post-op laparotomy, it's always easy to just give them another day. Consider TPN tomorrow if they're not eating.'

**P15 (DGH):** 'If they disagree with us, I can't force them and I go with their advice. If I still insist I want it, then I contact the consultant [gastroenterologist] directly, if I can change the decision...And most of the time they win. It's...I can't really...it's not about forcing them really. It's about convincing. It's like you request x-ray study, something CT scan. The request should convince the radiologist why you need it. And it's similar, you need to the nutrition team why this patient needs nutrition.'

**P16 (IFU):** 'I cannot think of any situation where I will...where the nutrition team will err on the side of conservatism when it comes to nutritional support and I am pushing for nutritional support. It's mostly the other way round.'

### Resolution

**P5 (TH):** 'It's generally managed, but it's not terribly good thing to admit to, by us saying, 'Yeah, the dietitians should not be seeing these patients please, you know, please ask them to stop seeing them.'

**P6 (TH):** 'So you try and explain your rationale for why you want to do X, you listen carefully to why their rationale for Y is, and you know, you've got to take account of your level of expertise in that area as a surgeon, and their level of expertise and usually, you'll come to a negotiated settlement if you like.'

**P7 (TH):** 'Generally, I don't tend to argue with the nutritionists if they saying their malnourished, they most probably are malnourished, right?'

**P13 (DGH):** 'And it takes a while to actually go, 'I'd like you to email me or if you're really worried, just pick up the phone and phone me through switchboard and just contact me.' And don't worry if I'm busy or whatever, I'll answer you. I will answer because if it's about my patient, I want to know.'

**P14 (IFU):** 'And for this group of surgeons, there's about four of us that do IF and IBD that sit on the MDT, we have really quite, you know, we're quite involved with it. I've never actually ever been challenged I think. I'm trying to think now. I don't I've had a requested for PN challenged.'

**P16 (IFU):** 'I've never had that I must say so I wouldn't actually know. I might just ask them to have a look again in a few days, but it's never really happened before. I mean, let's put it this way, I think the dietitians are very primed nowadays.'

### Ward vs intensive care

**P2 (TH):** 'If the patient goes back to the general ITU and the consultant surgeon says 'Needs TPN post-op', there is a pathway that they can have it straight away. Whereas if the patient doesn't, and actually ends up on an outliers ICU - so, we've got a cardiothoracic ICU and a neuro ICU - there the pathways aren't so clear, and there they don't get it.'

**P8 (TH):** 'So if I do an operation in the middle of the night or whatever. And then I say to the anaesthetists, 'Ok. They've got a central line. Can we keep one lumen free for TPN?' Then I'll put in my op notes, 'Please start TPN ASAP on ITU.'...when I do my evening ward round, then there don't seem to be issues. It just seems to kind of happen. But sometimes on the patients, on the wards, as I say, the TPN has to be 'approved' by the nutrition team.'

### Non-IFU vs IFU

**P11 (IFU):** 'And there's no doubt that we do things here that we know we can because we do it in other patients, so the IF side of these probably does inform some of what we do [in EGS].'

**P14 (IFU):** 'I think we probably are [too liberal with nutritional support]. I'm sure there are patients where we use it for three, four or five days. Again, I remember as a trainee, I think a week was the magic number. It wasn't worth starting it if you weren't going to use it for a week...you know, getting HPN for us is pretty straightforward. Whereas if you work in any other hospital, that's just you know, that's rocking horse poo.'

**P16 (IFU):** 'I think the fact that I know that we can, I wouldn't say fairly easily, but that we can set up a patient on PN with long term decompression or even home PN, has influenced my working in that I'm far more open to the idea that, you know, maybe this patient needs a period of a few weeks of assessment and optimisation and then having an operation rather than the other way around.'

**P17 (IFU):** 'So we know that we've got ease of access to TPN etc so we would be less likely to do an anastomosis in the context where we would, sort of, be doing it on a hope and a prayer...just because it's a relatively proximal piece of bowel, we have little compunction to taking out a relatively proximal piece of bowel [and forming a stoma].'

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|                                                                                                                                      | <p><b>P18 (DGH):</b> 'You have to work with what you've got. You learn that very early on...there are lots of people that work in privileged institutions that have a privileged role...but if you're jobbing away as a jobbing general surgeon, you have to work with what you've got.'</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Wider Context</b>                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p><b>Research</b></p> <p>'You'll never get ethics to starve half your EGS population and feed the other half.' <b>P14 (IFU)</b></p> | <p><b>Need for evidence</b></p> <p><b>P1 (TH):</b> 'Well, I think there's reasonable evidence that patients who are malnourished do bad with surgery and if we can improve it, you know, that would be to the benefit, really. But I'm not aware of any data that shows we can improve it in the emergency setting...Even if evidence is published, if a surgeon doesn't agree with it they'll just pick holes in it and not believe in it...even with a well, you know, a well-studied randomised trial.'</p> <p><b>P4 (TH):</b> 'Most of what we do is probably based on kind of instinct and experience rather than methodology and science.'</p> <p><b>P6 (TH):</b> 'These sorts of things, you ask two surgeons, you'll get to different opinions. If you ask a surgeon and anaesthetist, you'll definitely get two different opinions.'</p> <p><b>P10 (TH):</b> 'There are some studies that I'm aware of that show the earlier intervention, from a nutrition point of view, with bowel obstruction, the better the outcomes. But again, it's not great data – it's not randomised control trial data. It's sort of audit type data.'</p> <p><b>P12 (TH):</b> '...there's probably been, or there probably is, less of a research interest in emergency surgery than everything else...And it's also difficult to show improvement emergency care because of the multifaceted nature of it. It's like, I don't know, but with nutrition for example, to show that you've improved outcomes will be great, obviously, but it'd be quite difficult to do.'</p> <p><b>P13 (DGH):</b> 'So I think that the big thing now is in terms of nutritional markers. It is going to be picking out the real losers – you know, futility...I think that we should be able to go actually we've done these markers and your nutrition is appalling and doing you know, doing an anastomosis in your case is not viable...the other thing is that those people who you think have got reversible, a quickly reversible cause, so that we can all say, actually, this patient should just have TPN, you know, post-operatively even if you think they're going to start eating, can we pick up those a bit better?'</p> <p><b>P13 (DGH):</b> 'What we don't have I think is a very good understanding of what happens afterwards; what's their recovery like, what's the difference? Like what's the difference for us really feeding them up in the first two or three weeks for what their three-month and six-month outcomes of getting back up to, like functional outcomes? And in a hospital setting do we even care about that? Does the hospital care about what happens after?'</p> <p><b>P14 (IFU):</b> 'I think if you're really going to bring it in to practice and standardise it, I think there's a kind of unicorn data that's going to be incredibly difficult, and probably never be found. And that's kind of what, you know, can you quantify the impact? You know, what...you can measure one half - weight loss, BMI, grip strength - but what you can't say is this going to cause a 5% increase in mortality?'</p> <p><b>P18 (DGH):</b> 'But also we don't have good evidence, do we? But yeah, it's just crying out for an emergency general surgery trial or collaborative audit to see what do we do?'</p> <p><b>Need for standards</b></p> <p><b>P6 (TH):</b> 'But, you know, in some areas we don't really know what we're doing. But I think there are some areas where we do, where we can, where we could agree standards.'</p> <p><b>P9 (TH):</b> 'I really, really think that nutrition in the surgical patient should be talked about at AUGIS, ASGBI and ACPGBI [major UK surgical societies]. But it needs to be chalked in a way that surgeons understand.'</p> <p><b>P11 (IFU):</b> 'I'm stuck because I genuinely don't know how you would improve all of that. And you know, I mean there are guidelines as we have described from ESPEN, from NICE, but you know the trouble is with guidelines is that you've got to read them to understand them, you know. And people don't find time to do that, or because it's not necessary.'</p> <p><b>P16 (IFU):</b> '...it's all still kind of guidance. None of it becomes mandatory just because it's published somewhere. You nearly want to say well actually, NICE maybe needs to take this on or somebody needs to take this on and say it becomes maybe a key performance indicator: the proportion of patients coming with a small bowel obstruction who have nutritional assessment within 24 hours.'</p> <p><b>External factors</b></p> <p>'I'm in the privileged</p> <p><b>Hospital nutrition</b></p> <p><b>P1 (TH):</b> 'And even that's bad because, you know, even patients when they get eating their appetite's gone, the hospital food is maybe not what they require. It's maybe got, you know, it's done very cheaply.'</p> |

position.' **P16 (IFU)**

**P3 (DGH):** 'Even the quality of the hospital food that people get after they've had their appendix out. You know, it's unlikely to compromise them...I'm not sure that particularly high on the whole NHS radar.'

#### **Postcode lottery**

**P3 (DGH):** 'Yeah, potentially, but also the different areas are going to have slightly different problems and you know, if you're living two different postcodes, you know, probably a very different outlook to some of the patients that we get here. And also, just for generally for health care is a different level of expectation of what you're likely to get. So, you know, some people I see are starving to death, and they just think, well, that's normal for them and that's what they're expecting. Whereas, you know, if you'd come in from, you know, area z [a more affluent area] or something like that, you'd have been at the GP's six weeks before and, you know, at the first sign of things. It's the access in healthcare, isn't it? It's part of it as well, I think.'

**P4 (TH):** 'I'm absolutely 100% sure it's nationwide. I'm sure there's some variation within those themes in terms of barriers.'

**P6 (TH):** 'I suspect that nutrition is probably, I think if you looked at a postcode of where your patients are from, you're probably looking at fairly different nutritional parameters based on your postcode just like many other things are.'

**P6 (TH):** 'But I work in a hospital where the surrounding areas where most of our secondary work comes from, it's extremely deprived. So I would imagine that the general nutritional index of the population, of the well population if you like, is pretty poor.'

#### **Funding**

**P3 (DGH):** 'I don't think the food is particularly bad here, but sometimes you look at it and go, 'I'm not surprised that nobody's eating it,' because you know the budget for food a day is, what about two pounds something I imagine, which is, you know, fairly ridiculous in this inflationary world.'

**P16 (IFU):** 'I'm in a slightly odd unit, of course. I'm in the privileged position where we can afford and we have the facilities to keep the patient either in hospital for prolonged period of time on PN and build them up and then have an operation, or even if it's gonna take longer, get them set up on home parenteral nutrition and send them home.'

**P18 (DGH):** 'Whether our trust is backward or poorly funded or whatever, I don't know. But like any small hospital when you've got...[you're] dependent on a couple of people and if they're not there and/or your requirement for that is not on a daily basis, funding that process is hard.'

Abbreviations: Association of Coloproctology of Great Britain and Ireland (ACPGBI); Association of Surgeons of Great Britain and Ireland (ASGBI); Association of Upper Gastrointestinal Surgery of Great Britain and Ireland (AUGIS); Emergency general surgery (EGS); Intercollegiate Surgical Curriculum Programme (ISCP); Intestinal failure (IF); Multidisciplinary team (MDT); National Health Service (NHS); National Institute for Health and Care Excellence (NICE); Peripherally inserted central catheter (PICC); Total Parenteral Nutrition (TPN).



**Table S27:** Illustrative quotes related to clinical decision making by surgeons

| Theme and subtheme                                                                                                                                             | Supporting quotations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>To Join Or Not To Join</b>                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Risk taking</b><br><br><i>'If they're malnourished it's just another reason not to join them up.'</i><br><b>P13 (DGH)</b>                                   | <p><b>P1 (TH):</b> 'It might change what I do at the operation. It might sway me to not do an anastomosis. But that would be a part of the global picture. It wouldn't be not doing any anastomosis just because they're malnourished perhaps but, you know, if they're extremely malnourished, you probably wouldn't be doing any intra-abdominal anastomosis if you can avoid it.'</p> <p><b>P10 (TH):</b> 'Yes, in the sense that if they are malnourished, their healing will probably not be as good. So if I have to do something in an emergency, they're more likely to get stoma then anastomosis, or they may get an anastomosis and a defunctioning stoma above it.'</p> <p><b>P11 (IFU):</b> 'You know, you're unlikely to get away with an anastomosis in really suboptimal settings in which malnutrition or undernutrition is one, isn't it?'</p> <p><b>P13 (DGH):</b> 'I mean, the main thing is, is that I think if they're septic, they're already malnourished and they're frail, the main concern is your ability to withstand the leak – the second hit – which is more severe.'...This has lead to a change in practice from a "shit or bust" type approach'...This is where patients are joined despite the risk of failure [an anastomotic leak] being so catastrophic that if it happens they will die. It appears that nowadays a more conservative approach that avoids an anastomosis, and as such avoid the risk of a leak, and the idea is survival, and maximising survival is to give you a stoma.'</p> <p><b>P14 (IFU):</b> 'I think the decision of to join or not to join is probably more from other factors than just malnutrition... Malnutrition is just another tick in that box.'</p> <p><b>P16 (IFU):</b> And if you then try to do an operation, I would be far more reluctant to make an anastomosis rather than just bring out a stoma of some description.'</p> <p><b>P17 (IFU):</b> 'So at that stage it sort of doesn't necessarily impact the decision to operate or not unless they're extremely malnourished and not thought to survive the operation to leave hospital. But obviously it impacts on the intraoperative decision making in terms of anastomoses etc.'</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Site of anastomosis</b><br><br><i>'Somebody who is malnourished with albumin in their boots, I'm less likely to do certain anastomoses.'</i> <b>P7 (TH)</b> | <p><b>P7 (TH):</b> 'Let's say on somebody who is malnourished with albumin in their boots, I'm less likely to do certain anastomoses. So I'm more likely to do stoma, which is safer rather than because if they are on a low albumin, you know that the risk of leaks is much higher.'</p> <p><b>P9 (TH):</b> '[in the context of hypoalbuminaemia]...you are not going to be doing an anastomosis in that patient and if the problem's in the small bowel, for example, you may end up with a high output ileostomy and therefore you're going to compound the already poor nutritional state that that patient is likely in.'</p> <p><b>P10 (TH):</b> 'I had one where I probably, well regretted, anastomosing her because she leaked after a right hemi. It could have been multifactorial...it could have been a variety of comorbidities, but [she] was nutritionally poor. Elderly, decision was not to give a stoma because being an older person managing an ileostomy can be challenging but with hindsight perhaps would have been better off taking that risk than the risk of anastomotic leak.'</p> <p><b>P11 (IFU):</b> 'I can think of, you know, a number of occasions where we've had, you know, elderly, frail patients whereby, you know, you take the risk of a high anastomosis, a proximal anastomosis because the risk of making a loop stoma and a high output stoma is far greater for that patient... You know, you would be daft to consider getting...you know, you're unlikely to get away with an anastomosis in really suboptimal settings in which malnutrition or undernutrition is one, isn't it?'</p> <p><b>P11 (IFU):</b> 'A good example is an elderly patient with an ischemic segment about within a femoral hernia where it's quite proximal and whereby bringing those ends as a stoma would condemn them to TPN, which is probably higher risk than you making an anastomosis and allowing the patient to get their gut back in circuit. And so you know, I do sort of thinking along those lines.'</p> <p><b>P14 (IFU):</b> 'So if they lost loads of weight, they're obviously malnourished coming in, then obviously we do less. Less is better than more when it comes to surgery. So we wouldn't be joining them up. We wouldn't probably be taking on a high risk anastomosis.'</p> <p><b>Hospital setting</b><br/> <b>P16 (IFU):</b> 'And again the fact that I work in an IF unit where we're used to dealing with high...with proximal jejunostomies and high stomas means that I don't really care that much about that whether I'm going to bring out a terminal ileostomy or a proximal jejunostomy because we'll deal with it.'</p> <p><b>P17 (IFU):</b> 'We would probably have a slightly different practice than much of the rest the UK because of the degree of support that we have with our intestinal rehab unit. So we know that we've got ease of access to TPN etc so we would be less likely to do an anastomosis in the context where</p> |

|                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                               | <p>we would, sort of, be doing it on a hope and a prayer...just because it's a relatively proximal piece of bowel, we have little compunction to taking out a relatively proximal piece of bowel [forming a stoma] rather than doing anastomosis, if in the context of a patient who's malnourished or had ischemia. So, I think that probably is a slightly different practice than other places because they know that they don't have necessarily as good TPN support and may feel pushed towards doing an anastomosis.'</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Nutritional Support</b>                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p><b>Timing</b></p> <p>'They tend to have a slightly smoother course, I think, if they're in a better shape beforehand.' <b>P10 (TH)</b></p> | <p><b>Diagnosis affecting timing</b></p> <p><b>P3 (DGH):</b> 'So, you know, if we'd have just ploughed in and done surgery on him, he'd have just fallen apart and died, I'm sure. And it's sometimes that bit of knowing when not to operate and go, 'Right. Yeah. This all looks really horrible but actually recognising that you're so nutritionally deplete that if we try and do something, it isn't going to work.'</p> <p><b>P6 (TH):</b> 'I think that the indications for TPN are pretty niche in the emergency setting...I think, I think if I know what operation I'm gonna do, I can plan. But in a lot of occasions you're not sure exactly what you're gonna do.'</p> <p><b>P7 (TH):</b> 'Do I need to get them any parenteral nutrition now or will I have to do it after a day or two? Or like, do I have to start it before surgery? Or, which takes a priority? Do they need surgery first and then try to top them up? Or do I need to start it now before surgery and then to continue it afterwards?'</p> <p><b>P9 (TH):</b> 'They were referred originally for, 'Can you sort out this adhesional bowel obstruction in a war zone?' and we turn around and go, 'Interesting you're thinking about an operation when nutritionally, they're shocking.'</p> <p><b>P10 (TH):</b> 'They tend to have a slightly smoother course, I think, if they're in a better shape beforehand.'</p> <p><b>P15 (DGH):</b> 'Peritonitis is different to bowel obstruction. And you know, peritonitis, they can deteriorate within hours and they can get into multi-organ failure and they can die from sepsis. So, you need to open the abdomen and to clear it. So, there is no time to consider TPN especially when it is stercoral or upper GI perforation.'</p> <p><b>P16 (IFU):</b> 'If somebody...if I feel that somebody needs TPN, there's no point giving TPN for a few days prior to an operation. There's absolutely no value in giving a few days of TPN and then doing an operation. If you're gonna give TPN with the view to nutritionally optimising them for an operation, you need to give it for at least a few weeks.'</p> <p><b>Pre- vs post-operative nutritional support</b></p> <p><b>P3 (DGH):</b> 'I think they sort of split down into people who've been unwell for a while and have been, you know, clearly losing weight prior to coming to you for whatever reason, be that malignancies you know, a benign stricture, mental health concerns, you know, safeguarding issues, all that sort of stuff. And I think to my mind, they fall into one category. And then there's the other people who are not nutritionally compromised until you meet them and what you do to them and the consequences and that leaves them suddenly nutritionally compromised.'</p> <p><b>P4 (TH):</b> 'Generally speaking, we probably have two cohorts. We have the acutely malnourished who have been kind of long term ill and we see that in things like chronic cholangitis and that sort of thing, for example. 'And then we've got kind of the post-op patients who are, you know, long term not feeding for whatever reason, post-laparotomies, post-small bowel obstructions, long term ileus, that sort of thing.'</p> <p><b>P6 (TH):</b> 'You know, your fit, young 20 year old who's got a band adhesion or something, you're probably not gonna focus too long on that but you know, your 70 year old who's he looks like she's about eight stone you who looks got an advance malignancy, then that's different. So, I think the level of detail you go in depends upon the patient.'</p> <p><b>P8 (TH):</b> 'an IBD patient or they've been somebody who's been obstructed for a while and they're malnourished when they come in or difficult complex surgery where you know they're going to have a prolonged recovery afterwards...And then really it's kind of what, what they've, what they've come in with really. You know, bowel obstruction, cancer, active, inflammatory bowel disease.'</p> <p><b>P18 (DGH):</b> 'And we're talking about TPN at the team brief before a laparotomy not five days later on ITU, having an argument with whoever's turned up to say yes or no to venerate your decision about what you know to be correct.'</p> |
| <p><b>Delivery pathways</b></p> <p>'It's very much, you know, if you want someone</p>                                                         | <p><b>P3 (DGH):</b> 'There's nothing else I can think of particularly that we use as an organisation that says these people are at risk and this is what you need to do. There probably ought to be but there isn't one.'</p> <p><b>P7 (TH):</b> 'I generally try to, because if they go to ITU – fingers crossed, which rarely happens – but like you try, you know, in the op note straight away say that they need TPN from following day.'</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

on TPN, you say,  
'Put them on  
TPN.' **P4 (TH)**

**P9 (TH):** 'So we get the TPN, as it's commonly known, up and running very early on this unit and that's just as a hangover because that's part the management for pancreatitis. But what it also means is that for our laparotomy patients that have come in – perforated diverticular disease – they are unlikely to get back to eating and drinking normally so preoperatively, we will hammer them with nutrition and start that process before they're even in theatre. It then allows ITU who then take the patient to critical care post their NELA laparotomy to say, 'All right. They've got a line in. Let's continue TPN.'

**P11 (IFU):** 'There are also ready-made bags for IV nutrition but as the patients are known to the nutritional support team, they get bespoke bags. And if they are already known to the intestinal failure team but are on a surgical ward, their nutritional support is compounded by our IF unit, and they go up there to get the bag and have it connected.'

**P13 (DGH):** '...most of the protocols and policies are developed for the nutrition team to start TPN. But it tends to be, it seems to be fairly clinician-directed in the sense that you make a referral saying, 'I think they need to start TPN.' And they'll come back and say, 'We'll review them and say yes or no.' I don't think, I've not seen that many patients where they just randomly come and say, 'I think we should start your patient on TPN,' without ever us asking the question.'

**P18 (DGH):** 'Why haven't we got a prescribed ERAS program for all these emergency patients to get them out of hospital quicker to...you know, because they're just more at risk than all the elective patients we tee up and investigate to the hilt beforehand. And, you know, we're all over them like a rash, then we sort of leave, comparatively, all these other patients to just get on with it because well, 'They're ill so it's fine.' If you've got elective patient, you know it's hard to cope with complications because you've sort of taken someone relatively well off the street and doing something to them that's going to potentially affect their morbidity and mortality. But if you've got someone who's desperately sick, we're so much more accepting of 'whatever will be, will be' because they've turned up in a mess. But we need to sort of reverse that mentality and be all over them because we could actually probably make a bigger difference to them.'

Abbreviations: Total Parental Nutrition (TPN).

## Appendix 4

This section includes:

- Additional files to support Paper 4
  - **Additional File 1:** Research governance
  - **Additional File 2:** Participant invitation email
  - **Additional File 3:** Participant Information Sheet
  - **Additional File 4:** Methodology
  - **Additional File 5:** Initial instrument
  - **Additional File 6:** Final instrument
  - **Additional File 7:** Study user interface
- Supplementary tables for Paper 4
  - **Table S28:** Association of participant response and experience of intestinal failure
  - **Table S29:** Association of participant response and surgeon seniority
  - **Table S30:** Reasons why screening for malnutrition is not performed all the time according to surgeon seniority and experience of intestinal failure
  - **Table S31:** Responsible person for identifying malnutrition in emergency surgical patients according to surgeon seniority and experience of intestinal failure
  - **Table S32:** Responsible person for managing malnutrition in emergency surgical patients according to surgeon seniority and experience of intestinal failure
  - **Table S33:** A summary of the free text comments regarding screening and assessment for malnutrition pre- and post-operatively

## **Additional files to support Paper 4**

### **Additional file 1: Research governance**

#### **Ethical approval**

This study was reviewed the University of Sheffield Medical School's Ethics Review Committee and approval was granted on 7<sup>th</sup> December 2022 (UREC 050436). NHS Research Ethics Committee approval was not required as the participants were NHS staff were recruited only by virtue of their profession.

#### **Informed consent**

Potential participants were invited by e-mail to read a Participant Information Sheet. This explained the purpose of the study, how data would be stored, the study investigators and the duration of the survey. It was explicit that their involvement in the study was voluntary, and who to contact if there were any issues.

Survey consent was implied by participants clicking on a link in the invitation email, and subsequently on another link agreeing to continue on the welcome page. Participants were advised they can withdraw from the survey up until submission of their survey form.

#### **Confidentiality**

Survey responses were anonymous. Participants were offered to be kept informed regarding the findings of this study, any future studies relating to nutrition in emergency general surgery, or to avoid reminder emails to complete the survey by providing an email address at the end of the survey. It was explained that their email address would not be linked to their responses. Databases were password protected and stored as per the data management plan.

## Additional file 2: Participant invitation email



### **Nutrition in Emergency General Surgery: Who would you feed?**

Subject: Can you please help with a new study: Who do we feed in EGS?

Dear Emergency General Surgery consultant

We are inviting you to take part in a study that explores who you would give nutritional support to in the EGS setting.

The link to this study is: [https://bit.ly/who\\_do\\_we\\_feed\\_in\\_EGS](https://bit.ly/who_do_we_feed_in_EGS) . Please also circulate this around your department to the surgical registrars (ST3-8, SAS, associate specialists, trust grades) and other consultants colleagues. It takes approximately 15 minutes to complete and can be done on a mobile phone. Your answers will remain anonymous. It is supported by the ASGBI.

Along with a few background questions, the study comprises of a series of 25 clinical scenarios on which you are asked to make a hypothetical decision about whether to start artificial nutritional support to meet the requirements of the patient or not. This will allow us to explore the importance you place on various factors influencing your decision. It finishes with a few questions about your practice and training.

As before, this study is part of a set of wider research studies, and will contribute towards the final study of my PhD at the University of Sheffield. It has ethical approval.

A Participant Information Sheet can be found at: [https://bit.ly/who\\_do\\_we\\_feed\\_in\\_EGS\\_PIS](https://bit.ly/who_do_we_feed_in_EGS_PIS)

**Thank you for considering taking part in the study. I am very grateful for your support.**

Daniel Ashmore

Clinical Research Fellow/ Surgical registrar

Research and Innovation Team, Research Office, Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust, West Block, Doncaster Royal Infirmary, Armthorpe Road

Doncaster, DN2 5LT

Email: [dlashmore1@sheffield.ac.uk](mailto:dlashmore1@sheffield.ac.uk)



Invitation 1.1 dated 17/12/2023

## Additional file 3: Participant Information Sheet



### **Nutrition in Emergency General Surgery:** **Who do we feed?**

#### **Participant Information Sheet**

Dear colleague

We are writing to you to invite you to participate in the above research study to investigate nutrition in emergency general surgery (EGS). This study is part of a wider research study, and will contribute towards my PhD at the University of Sheffield. If there is anything that is not clear, or if you would like more information, please ask us.

#### **1. What is the purpose of the study?**

This study will primarily aim to establish senior decision makers' current practices, on a national scale, in identifying malnutrition in NELA-eligible EGS patients and whether these confirm the findings from a previous qualitative study. It will also aim to determine the impact of key variables on senior decision makers' treatment preferences regarding nutritional support offered to these patients.

Emergency general surgery provides complex management for patients admitted with an acute surgical pathology. It is known that a subset of EGS patients are very high risk patients in the UK and worldwide. EGS patients also have an approximately eight times greater risk of mortality than elective admissions. In order to provide nutritional support to patients, the process can be considered to consist of three steps: identification, stratification and implementation. Each step is dependent on the previous. Evidence suggests that once the decision for nutritional support is made, the process of implementing it is relatively quick. The 'delay' to starting nutritional support is within the decision making process of how we identify malnourished NELA-eligible patients from the point of admission to the time of decision that they need some form of nutritional support. In order to make subsequent changes to the process, it is important to understand why this is the case and the contextual barriers within which these complex decisions are made.

#### **2. What will I have to do if I take part? Please take time to read and understand what the study will involve. You can speak to the research team who will answer any questions you may have.**

This study involves a survey of **7 questions** and **25 scenarios**; it will take you approximately **15 minutes** to complete it. The survey is hosted by Qualtrics, an online platform approved by the University of Sheffield. You will be required to click a link to proceed to this study and this will be considered as your consent to take part.

#### **3. What alternatives are there if I don't take part?**

If you decide not to take part in the study, then we will respect your wishes. There will be other studies we may approach you about in the future.

#### **4. What are the benefits of taking part?**

The information we collect from you and others will hopefully help improve the nutritional care for surgical patients in the future. You will therefore have assisted in this process.

**5. What are the disadvantages and risks associated with taking part in this study?**

Apart from your time involved in the study, there is no additional risk to your health from taking part in the study.

**6. Will I get paid for taking part?**

No, you will not receive any payment for taking part in this study.

**7. What will happen if I don't want to carry on with the study?**

You can stop taking part in the study at any point until submission of the survey, without giving any reason.

**8. What if there is a problem during the study?**

If you have any concerns or questions about this study, please contact Mr Daniel Ashmore, Clinical Research Fellow. Details can be found at the bottom of this information leaflet. If you have concerns about the way the survey was conducted or safeguarding concerns, please raise these by contacting Mr Matthew Lee or Dr Vanessa Halliday, supervisors of Mr Ashmore's PhD. Alternatively, Prof John Newell-Price (Acting Head of Departments of Division of Clinical Medicine; not involved in the research study) can be contacted.

**9. Will my taking part in this study be kept confidential?**

Yes. Your responses will be anonymous. You will be required to include a GMC to ensure only eligible participants complete the study but it will not be linked to your answers. You will be offered to be kept informed regarding the findings of this study, any future studies relating to nutrition in emergency general surgery, or to avoid reminder emails to complete the survey. If you provide your email address at the end of the study then we will use your email address only for this purpose and it will not be passed on to any other party. Your email address will also not be linked to your study responses.

**10. What are the choices about how my information is used?**

You can stop taking part in the study at any point until submission of the study, without giving any reason.

**11. What do you do with my information?**

The University of Sheffield is the Sponsor for this study. The study data will be stored securely and analysed at the University of Sheffield. The University of Sheffield will act as the data controller for this study. This means that the University of Sheffield is responsible for looking after your information and using it properly.

**12. What will happen to the results of the study?**

The results will be presented at conferences and published in peer-reviewed scientific journals. If a publication results from this research, it will be made available to you at the following academic website: <http://www.ncbi.nlm.nih.gov/pubmed/>. Under no circumstance will you be identified by name in any presentation or report.

**13. Who is organising and reviewing the study?**

This study has been reviewed by the University of Sheffield's Research Ethics Committee, who protect your safety, rights, wellbeing and dignity. The University of Sheffield has overall responsibility for the study. This study is unfunded.



**14. Who do I contact if I need further information?**

Mr Daniel Ashmore  
PhD student/ Clinical Research Fellow  
University of Sheffield  
[dlashmore1@sheffield.ac.uk](mailto:dlashmore1@sheffield.ac.uk)

Research supervisors:  
Mr Matthew Lee  
Project Supervisor  
[m.j.lee@sheffield.ac.uk](mailto:m.j.lee@sheffield.ac.uk)

Dr Vanessa Halliday  
Project Supervisor  
[vanessa.halliday@sheffield.ac.uk](mailto:vanessa.halliday@sheffield.ac.uk)

University of Sheffield (independent contact, not involved in the research study) for any concerns  
Prof John Newell-Price  
Acting Head of Department  
[j.newellprice@sheffield.ac.uk](mailto:j.newellprice@sheffield.ac.uk)

**Thank you for reading this leaflet and considering taking part in the study.**

## Additional file 4: Methodology

### Survey development

The survey (study 4) was designed separately to the discrete choice experiment (study 5) but delivered simultaneously to the same population to limit burden to participants. The latter used scenario-based questions to derive the relevance of certain factors in decision making and will be reported in Chapter 11 as the underlying aims, methodology, findings are markedly different.

### Item generation

Potential items were generated with reference to current nutrition guidelines, the existing literature(43,98,109,112), the findings from Study 1 (systematic review), the findings from study 2 (NELA Lead survey) and expert opinion (the supervisory group). This expert panel consists of a registered dietitian, an academic surgeon and a colorectal surgeon with an interest in nutrition. All have experience with survey design. A summary of the domains is shown (**Additional File Table 12**)

**Additional File Table 12:** Domains identified through item generation

| Survey domains                          | Theme                                                                                               | Source derived                                                                                                   |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| <b>Participant demographics</b>         | Grade, hospital setting if consultant, experience with intestinal failure, region of work/ training | Literature, study 2 (NELA survey), study 3 (interviews)                                                          |
| <b>Awareness, practice and barriers</b> | Awareness: outcomes, skill for surgeons                                                             | Literature, study 3 (interviews), expert opinion, guidelines                                                     |
|                                         | Practice: screening/ assessment, confidence, collaboration, seeking help, use of research           | Literature, study 1 (systematic review), study 2 (NELA survey), study 3 (interviews), expert opinion, guidelines |
|                                         | Barriers: confidence, resources, training                                                           | Study 2 (NELA survey), study 3 (interviews),                                                                     |
| <b>Identifying malnutrition</b>         | Tools and methods used                                                                              | Literature, study 1 (systematic review), study 2 (NELA survey), study 3 (interviews), expert opinion, guidelines |
| <b>Decision making</b>                  | Planning ahead, change in clinical management (and use of stomas)                                   | Study 3 (interviews)                                                                                             |

In keeping with the nature of MMR, the survey questions were mapped specifically to the previous qualitative study (**Additional File Table 13**).

**Additional File Table 13:** Mapping of survey questions with framework from study 3 (interviews)

| Themes                                    | Subthemes                     | Addressed in question number |
|-------------------------------------------|-------------------------------|------------------------------|
| <b>How surgeons identify malnutrition</b> |                               |                              |
| <b>The Surgeon</b>                        | <i>Knowledge</i>              | 4, 13                        |
|                                           | <i>Experience</i>             | 1, 2, 7, 13a                 |
|                                           | <i>Planning ahead</i>         | 20, 21                       |
| <b>The Patient</b>                        | <i>Selection</i>              | 14, 19                       |
|                                           | <i>Composition</i>            | 15, 16, 17, 18               |
|                                           | <i>Clinical progress</i>      | 6                            |
|                                           | <i>Operative strategy</i>     | 18                           |
| <b>The Institution</b>                    | <i>Collaboration</i>          | 8, 10a, 11a                  |
|                                           | <i>Extended surgical team</i> | -                            |
| <b>Barriers experienced by surgeons</b>   |                               |                              |
| <b>The Surgeon</b>                        | <i>Understanding</i>          | 4a, 13a, 13b                 |
|                                           | <i>Culture</i>                | 5                            |
|                                           | <i>Ownership</i>              | 10, 10a, 11, 11a, 6a         |
|                                           | <i>Time constraints</i>       | 6a                           |
| <b>The Institution</b>                    | <i>Provision</i>              | 12                           |
|                                           | <i>Staffing</i>               | 12                           |
|                                           | <i>Conflict</i>               | -                            |
|                                           | <i>Hospital setting</i>       | 1a, 2                        |
| <b>The Wider Context</b>                  | <i>Research</i>               | 4a, 9                        |
|                                           | <i>External factors</i>       | 3, 9, 12                     |
| <b>Decision making</b>                    |                               |                              |
| <b>To join or not to join</b>             | <i>Risk taking</i>            | 21                           |
|                                           | <i>Site of anastomosis</i>    | -                            |
| <b>Nutritional support</b>                | <i>Timing</i>                 | 20                           |
|                                           | <i>Delivery pathways</i>      | -                            |

## Item selection

The domains and themes of interest were refined and those most relevant to the research question were selected (**Additional File Table 14**).

**Additional File Table 14:** Selection of survey domains

| Survey domains                          | Theme                                                                                                                | Reason for change                                                                                                                                                          |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Participant demographics</b>         | Grade                                                                                                                | Refined: grade of surgeon mapped to current general surgery training programme with phase 1 and phase 2 grades combined.                                                   |
|                                         | Hospital setting if consultant                                                                                       | Refined: hospital setting changed from DGH/teaching hospital/ IFU to 'Do you work in an intestinal failure unit?'                                                          |
| <b>Awareness, practice and barriers</b> | Identifying the nutritional status of patients, including malnutrition, is important for improving patient outcomes. | Malnutrition can significantly affect surgical outcomes.                                                                                                                   |
|                                         | Qu 6 (screening/ assessment)                                                                                         | Reduced ambiguity with clearer terminology by replacing 'routinely' with 'all'.                                                                                            |
|                                         | Qu 8 (seeking help from colleagues) and Qu 9 (using guidelines)                                                      | Moved to later in the survey to aid survey flow                                                                                                                            |
| <b>Identifying malnutrition</b>         | Tools and methods used                                                                                               | WASSP tool added as equivalent to MUST for participants from Wales                                                                                                         |
|                                         | Qu 12 (organisational support) and Qu 13 (surgical training)                                                         | Refined to remove ambiguity                                                                                                                                                |
|                                         | Qu 13a (surgical training)                                                                                           | Changed from being a conditional qu to mandatory qu to aid understanding how surgeons are trained in nutritional care                                                      |
|                                         | Qu 14-19 (matrix) on tools used to identify malnutrition                                                             | Reduced oral intake stratified to match corresponding DCE variables 'reduced oral intake until now' and 'reduced oral intake from now'                                     |
|                                         | Qu 20 (planning ahead) and qu 21(stoma vs anastomosis)                                                               | Removed: difficult to assess nuances of clinical management with single question. 'Planning ahead' may also be addressed to some extent in the discrete choice experiment. |
| <b>Conditional questions</b>            | Various                                                                                                              | Clarification added to question stems and answers                                                                                                                          |

## Operationalisation

As with Study 2 (NELA Lead survey), question stems were kept shorter than 20 words using non-leading and unambiguous language, avoiding modifiers. Directions to answer questions were given.

Free text or 'other' responses were used for many questions, offering an opportunity to capture unanticipated responses which may add richness to the responses and assist with triangulation of findings. Likert scales were used and presented in a negative to positive direction,. An 'I do not know' option was also presented as appropriate.

### **Survey formatting**

Study 4 (survey) and study 5 (DCE) were being combined in a user interface which would seamlessly appear to be a single survey. Lengthy consideration was given to a number of areas that would affect formatting, and possibly participant responses:

1. Study 4 (survey) then study 5 (DCE)
2. Study 5 (DCE) then study 4 (survey)
3. Random mixing of above options
4. Participants complete both studies separately by two separate links

Option 2 was selected. The methodology of study 5 is explained at length in chapter 5. In short, it is an experiment using hypothetical scenarios in attempt to delineate the influence several variables have on decision making regarding whether the participant would start nutritional support. The main priority was to minimise bias by not 'giving participants the answers' prior to completing it, which was considered option 1 might lead to. The second concern was to minimise participant dropout, which can happen for many reasons. While completing the DCE first may lead to survey fatigue as its very nature is repetitive, it was felt participants would be more likely to see rapid progress through the studies and therefore be more willing to complete both parts. Option 3 was not considered helpful as if there was participant dropout, understanding at what point this was and why this may have been would have been very difficult. Option 4 was considered too risky in that participants would potentially only complete one of the two studies, affecting interpretation of response and completion rates.

Additionally, a simple format with reminder emails facilitated through a recognised professional body (both studies had 'research support' from the Association of Surgeons of Great Britain and Ireland) was planned to reduce non-responder bias. The completion time was obtained from study testing. An adaptive format was used as shown in the Final Instrument.

### **Testing**

Each phase, including pre-testing, pilot testing and clinical sensibility testing, are discussed below.

### **Pre-testing**

This phase was achieved with input from the expert panel at the item selection and operationalisation stages of survey development.

### **Pilot testing**

The survey was piloted among one consultant and four non-consultant general surgeons that undertake EGS at Doncaster Royal Infirmary, a teaching hospital in the UK, using Qualtrics. This online platform hosted by the University of Sheffield proved adequate for study 2 (NELA Lead survey). All completed the survey.

### **Clinical sensibility testing/ acceptability**

Face and content validity was assessed using a feedback form based on the QQ-10(303) (**Additional File Figure 2**). Only questions considered relevant to this combined study were asked in the pilot study (**Additional File Figure 8**) for this study. Questions related to communication, relevance of a condition, completing the survey as part of routine care, or probing for an embarrassing or upsetting nature were disregarded as they were considered irrelevant for this type of study. However, questions related to ease of completion, enjoyment, length of study, and how complicated it was were retained. Additional feedback regarding survey design, question wording and completion time were also gathered and discussed among the expert panel.

Please circle the answers below each of the following 10 statements that best fit your feelings about the questionnaire that you recently completed.

Please use the boxes at the bottom of the next page to make additional comments.

1. The questionnaire was easy to complete

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

2. I enjoyed filling in the questionnaire

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

3. The questionnaire was too long

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

4. The questionnaire was too complicated

Strongly agree      Mostly agree      Neither agree or disagree      Mostly disagree      Strongly disagree

5. Do you have any comments or suggestions on how the questionnaire you used could be improved (e.g. its structure, appearance or design)?

6. How long (in minutes) did it take you to complete the questionnaire?

**Additional File Figure 8:** Assessment of face and content validity

### Development and pre-testing

The survey was piloted among five consultant and non-consultant general surgeons.

Overall, responses from the pilot study confirmed the survey was succinct, easy to complete and was relevant. All participants except one felt it was easy to complete. Three out of five participants enjoyed completing it (**Additional File Table 15**). The mean time for completion was five minutes for the survey section. One participant felt it might have taken longer if they had completed it fully. Free text responses advised the need for fewer questions per page and this was incorporated into the final survey design (**Additional File Table 16**).

**Additional File Table 15: Pilot study results**

| Participant          | Strongly agree | Mostly agree | Neither agree or disagree | Mostly disagree | Strongly disagree |
|----------------------|----------------|--------------|---------------------------|-----------------|-------------------|
| Q1, easy to complete | 3+1            |              |                           | 1               |                   |
| Q2, enjoyed it       | 1              | 2            | 1                         |                 | 1                 |
| Q3, too long         | 1              |              |                           | 1+1             | 2                 |
| Q4, too complicated  | 1              |              |                           | 1+1             | 2                 |

Total responses = 5.

**Additional File Table 16: Pilot study free text comments**

| Participant                                 | Feedback received                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Remedial action                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1, General surgeon, consultant, male</b> | <i>'Difficult to know how it could be made easier. I followed it okay as I am very familiar with assessment of malnutrition. Those not might struggle a bit more.'</i>                                                                                                                                                                                                                                                                                                                                                                                                                     | No change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>2, General surgeon, trainee, male</b>    | <i>'I really liked the combined survey/experiment. It was very short and actually relevant to my current practice rather than the typical survey out there.'</i>                                                                                                                                                                                                                                                                                                                                                                                                                           | Confirms DCE then survey format worked well.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>3, General surgeon, trainee, male</b>    | <i>'I am probably not a good person to test this on. I have a learning disability so the scenario whilst presented well, the subtle changes were difficult to delineate. This took a long time to complete and I got frustrated and sped through some of the questions. I would have preferred a vignette. It is a bland questionnaire, black and white and the scenarios go for quite a long period. I would do 3 and then get the person to click next. I think this makes you feel you are making progress with the questionnaire. The questions about nutrition were well-worded.'</i> | <p>Vignette not possible as outlined in chapter 10.</p> <p>Scenarios cut down from 5 per page to 3 per page. A progress bar was moved from the bottom to the top so it was visible at all times.</p> <p>University of Sheffield theme retained for consistency with brand representation, inclusive for all participants with colour blindness, and single colour surveys considered more organised than those made with multiple colours(373).</p> <p>No change to survey questions.</p> |
| <b>4, General surgeon, trainee, male</b>    | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>5, General surgeon, trainee, female</b>  | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |



## Reliability

Pilot study reliability was assessed as described (**Additional File Table 17**).

**Additional File Table 17:** Pilot study reliability

| Types of reliability                                                                             | How assessed?                                                                                                                   | Description                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Test-retest reliability</b>                                                                   | Not assessed                                                                                                                    | Small number of participants in the pilot study.<br><br>Respondents may review guidelines between repeat surveys and change response, particularly with DCE component.<br><br>There may be concerns over participant anonymity. |
| <b>Internal consistency</b><br><b>Equivalent/ parallel form</b><br><b>Split-half reliability</b> | Not assessed                                                                                                                    | Additional rewording questions would require generation of a significant question bank beyond study resources.                                                                                                                  |
| <b>Inter-rater reliability</b>                                                                   | Intra-class correlation of Likert scales in the pilot study not assessed as too few participants for meaningful interpretation. | N/A                                                                                                                                                                                                                             |

## Validity

Pilot study validity was assessed as described (**Additional File Table 18**).

**Additional File Table 18:** Pilot study validity

| Types of validity         | How assessed?                                                                                                    | Description                                                                                                       |
|---------------------------|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <b>Face validity</b>      | Feedback using a simple and short questionnaire based on key questions from the QQ-10 tool and written feedback. |                                                                                                                   |
| <b>Content validity</b>   | Feedback confirmed the study was relevant to current practice.                                                   | <i>'It was very short and actually relevant to my current practice rather than the typical survey out there.'</i> |
| <b>Criterion validity</b> | Not assessed                                                                                                     | No similar validated surveys identified.                                                                          |
| <b>Construct validity</b> | Not assessed                                                                                                     | Study included no abstract concepts to assess.                                                                    |

## **Administration**

The study opened in December 2023 for 10 weeks with two additional reminders to complete it. There were no incentives offered. Responses were anonymous, although participants were able to leave their email if they wished to be contacted in the future, be informed of findings or avoid reminder emails.

### **Method of administration**

Sampling was undertaken by a convenience route. The final study was designed and publicised widely to general surgeons by several routes. This included: surgeons who had previously registered an interest in previous studies by the research team; to members of the Association of Surgeons of Great Britain and Ireland (ASGBI), for which the study had received 'research support'; and, via social media platforms to general surgical trainee- and EGS-specific groups. A link was provided to complete the study. This allowed surgeons from all regions to partake in the study whilst keeping costs and resources to a minimum. Participant responses were gathered using Qualtrics survey software.

### **Response rates and sample size calculation**

There are 4,889 registered general surgeons in the NHS in March 2022 (2,605 consultants and 2,284 non-consultants)(350). A proportion of these will be breast surgeons and surgeons that do not participate on the EGS rota. ASGBI report to have 1200 active members trainee grade and above (data not published; confirmed by Carol McNair, Secretariat to ASGBI). This means 95 responses are required to achieve a 10% margin of error with a 95% confidence interval. With an estimated response rate of approximately 55% as based on study 2 (NELA survey), this required 159 surveys to be distributed.

## Reporting

The results from the survey are reported with reference to the CHERRIES guidelines(199).

## Total Survey Error (TSE) and Total Survey Quality (TSQ)

Using the same framework as discussed in chapter 5, sources of error in this study are addressed (Additional File Table 19).

**Additional File Table 19:** Strategies to address potential sources of error

| Domain                       | Subtheme                              | How addressed in this study                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Respondent selection</b>  | Sampling error                        | Sample size is limited by the number of general surgeons undertaking EGS in the UK. Advertising and research support by the largest representative surgical association in the UK via email and relevant social media groups, as well as trainee research networks. Multiple email reminders.<br>Self-selection bias inherent. 'IF experience' is self-determined and no definition is provided. |
|                              | Coverage error                        | Not all surgeons will be members of ASGBI. Social media promotion also performed.                                                                                                                                                                                                                                                                                                                |
|                              | Non-response at unit level            | Reminder emails distributed for non-responders.                                                                                                                                                                                                                                                                                                                                                  |
| <b>Response accuracy</b>     | Non-response at item level            | Anonymity, clear instructions for participants, and mandated answers for selected questions. Completion time of 15 minutes for both part (study 4 and study 5) may increase non-response; thorough explanation needed to convey importance of study to participants.                                                                                                                             |
|                              | Measurement error due to participants | Anonymity to encourage responses which differ from practice norms. Participant fatigue addressed above. Survey can also be started and completed at a separate date.                                                                                                                                                                                                                             |
|                              | Measurement error due to interviewers | Not applicable as web-based survey.                                                                                                                                                                                                                                                                                                                                                              |
| <b>Survey administration</b> | Post-survey error                     | Data management plan in situ.                                                                                                                                                                                                                                                                                                                                                                    |
|                              | Mode effects                          | Web-based survey known to have reduced response rates. Reminder emails will be distributed as necessary.                                                                                                                                                                                                                                                                                         |
|                              | Comparison error                      | No comparisons planned.                                                                                                                                                                                                                                                                                                                                                                          |

## Recruitment and survey administration

Surgeons working at registrar-level or above were eligible to complete the survey. This included surgeons in training and fellows post-certificate of completion of training, as well as SAS doctors, associate specialists, and trust grade surgeons. Surgeons working below the level of a registrar were excluded.

The final study was designed and publicised widely to general surgeons by several routes previously described. The email invitation explained the intent of the study and that it was a component of my wider PhD studies. It explained that no identifiable information was recorded, and provided contact details to answer any questions that may arise about the study. Participants were reminded to complete the study a maximum of three times over three months. This ensured timely survey responses are obtained without it being too burdensome for participants (for example, in comparison to weekly emails). Responses were anonymous, and no personally identifiable information was recorded. Participants were offered to be kept informed regarding the findings of this study, any future studies relating to nutrition in emergency general surgery, or to avoid reminder emails to complete the survey. They could provide their email address but were reminded that it would not be linked to their survey responses. Recruitment did not take place through direct approach to NHS sites, therefore NHS ethics are not relevant to this study.

## Additional file 5: Initial instrument

### Introduction page

#### ***How do we identify malnutrition among EGS patients? A survey of senior decision makers***

Thank you for taking part in this study.

It takes approximately x minutes to complete.

When answering the questions in this survey, please only focus on NELA-eligible emergency general surgical (EGS) patients with reference to your usual practice and NHS place of work.

As a reminder, your responses will be anonymous. However, this is an open survey and a GMC number is required to ensure only eligible participants (surgeons) complete the study. It will not be linked to your answers.

By pressing next, you are consenting to continue with the study.

## **Background**

**1. What is your current grade?** Please select one from the drop down list.

- Consultant
- ST8
- ST7
- ST6
- ST5
- ST4
- ST3
- SAS doctor, associate specialist, trust grade
- Other. *If you selected 'other', please type your answer into the box here* \_\_\_\_\_

**1a If consultant selected, what type of hospital setting do you currently work in?**

Please select one from the drop down list.

- District general hospital
- Teaching hospital
- Hospital with an intestinal failure unit

**2. Do you currently manage, or have previous experience of managing, patients on an intestinal failure unit?**

- Yes
- No

**3. What region do you currently work or train in?**

Please select one from the drop down list.

- East Midlands (North)
- East Midlands (South)
- East of England
- Ireland
- Kent, Surrey & Sussex
- North Central & East London
- North West London
- South London (South East)
- South London (South West)
- North East
- North West (Mersey)
- North West (North West)
- Northern Ireland
- Scotland (East - Dundee)
- Scotland (North - Aberdeen)
- Scotland (South East - Edinburgh)
- Scotland (West - Glasgow)
- South West (Peninsula)
- South West (Severn)
- Thames Valley
- Wales
- Wessex
- West Midlands
- Yorkshire & the Humber

### **Awareness, practice and barriers**

There is no universally accepted definition of malnutrition. However, it typically refers to the deficiency, excess or imbalance of nutrients, which results in an adverse effect for patients.

*Please indicate the extent to which you agree or disagree with the following statements.*

|    |                                                                                                                                                                                                                   | Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------|----------------------------|-------|----------------|
| 4  | Identifying the nutritional status of patients, including malnutrition, is important for improving patient outcomes                                                                                               | o                 | o        | o                          | o     | o              |
| 5  | Identifying the nutritional status of surgical patients, including malnutrition, is an important skill for surgeons                                                                                               | o                 | o        | o                          | o     | o              |
| 6  | I routinely screen and/ or assess for malnutrition in emergency general surgical patients                                                                                                                         | o                 | o        | o                          | o     | o              |
| 7  | I feel confident determining the nutritional status of emergency surgical patients, including identifying malnutrition                                                                                            | o                 | o        | o                          | o     | o              |
| 8  | I regularly seek help or advice from colleagues (a dietitian, NST or senior colleague) when deciding a patient may be, or is, malnourished                                                                        | o                 | o        | o                          | o     | o              |
| 9  | The methods I use to determine a patient's nutritional status are based on published guidelines (local, national, or international)                                                                               | o                 | o        | o                          | o     | o              |
| 10 | Surgeons are primarily responsible for <b>identifying</b> malnutrition in emergency surgical patients                                                                                                             | o                 | o        | o                          | o     | o              |
| 11 | Surgeons are primarily responsible for <b>managing</b> malnutrition in emergency surgical patients                                                                                                                | o                 | o        | o                          | o     | o              |
| 12 | There is adequate organisational support required to identify malnutrition for all emergency surgical patients (eg number and access to dietitians and other staff, presence of nutrition support teams, funding) | o                 | o        | o                          | o     | o              |
| 13 | The training that surgeons receive to determine a patient's nutritional status, including identifying malnutrition, is adequate                                                                                   | o                 | o        | o                          | o     | o              |

**Conditional questions depending on the answers given to questions 4-13**



4a. If strongly disagree, disagree or neutral, *why have you selected this answer?* Please select all that apply.

- Would not improve patient outcomes (reduce complications or mortality)
- Insufficient research or evidence in the literature
- There are other factors that are more important for improving patient outcomes
- Other. ***If you selected 'other', please type your answer into the box here***\_\_\_\_\_

6a. If strongly disagree, disagree or neutral, *why have you selected this answer?*

- Not part of my role
- No time to screen for malnutrition in an emergency surgery setting
- Would not change immediate management
- Lack of appropriate training
- Lack of resources (eg dietitian to refer to or ask advice from)
- I do not know
- Other. ***If you selected 'other', please type your answer into the box here***\_\_\_\_\_

10a. If strongly disagree, disagree or neutral, who is primarily responsible for **identifying** malnutrition in emergency surgical patients? Please select one from the drop down list.

- Dietitian
- The nutrition support team (NST)
- Gastroenterologist
- Pharmacist
- Nutrition specialist nurse
- I do not know
- Other. ***If you selected 'other', please type your answer into the box here***\_\_\_\_\_

11a. If strongly disagree, disagree or neutral, who is primarily responsible for **managing** malnutrition in emergency surgical patients? Please select one from the drop down list.

- Dietitian
- The nutrition support team (NST)
- Gastroenterologist
- Pharmacist
- I do not know
- Other. ***If you selected 'other', please type your answer into the box here***\_\_\_\_\_

13a. If strongly disagree, disagree or neutral, *How have you learned how to identify malnutrition among EGS patients?* Please select all that apply.

- Medical school
- Training course
- Senior colleague (eg observed consultant practice)
- Nutrition support team or equivalent
- Allied health professional (eg dietitian)
- Previous patient cases
- Other. ***If you selected 'other', please type your answer into the box here***\_\_\_\_\_

13b. If strongly disagree, disagree or neutral, *How should training be improved?* Please select all that apply.

- Specific teaching at medical school
- A training course aimed at surgeons
- Local/ Deanery teaching
- Other. ***If you selected 'other', please type your answer into the box here***\_\_\_\_\_

### **Identifying malnutrition**

On reviewing a patient for the first time and in the context of emergency general surgery, how often do you routinely use the following when determining a patient's nutritional status?

|    |                                              | Never                 | Rarely                | Occasionally          | Regularly             | All the time          |
|----|----------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 14 | Malnutrition Universal Screening Tool (MUST) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 15 | Albumin                                      | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 16 | Body mass index                              | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 17 | Percentage weight loss in time               | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 18 | Reduced oral intake                          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 19 | End of bed 'clinical' impression             | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

### **Decision making**

*Please indicate the extent to which you agree or disagree with the following statements.*

|    |                                                                                                                                                                                                | Strongly disagree     | Disagree              | Neither agree nor disagree | Agree                 | Strongly agree        |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|----------------------------|-----------------------|-----------------------|
| 20 | Identifying malnutrition in emergency patients pre-operatively/ on admission may help plan future nutritional support                                                                          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>      | <input type="radio"/> | <input type="radio"/> |
| 21 | I am more likely to give a patient a stoma if I believe them to be malnourished, or they have been confirmed to be (by any means), in comparison to anastomosing without a defunctioning stoma | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>      | <input type="radio"/> | <input type="radio"/> |

### **Final page**

Thank you for taking part in the survey.

If you would like to be kept informed regarding the findings of this study, any future studies relating to nutrition in emergency general surgery, or to avoid reminder emails to complete the above survey, please enter your email address below.

Your email address will NOT be linked to any of your answers in this study.

---

## Additional file 6: Final instrument

The final instrument was designed and developed in response to the pilot feedback. There were three sections, headed by an introduction and thanks, and closed by an ending and email request. The background section captured limited demographic data about respondents including grade of surgeon, self-reported experience of managing patients with intestinal failure and current region of work. Following the discrete choice experiment (study 5), the questions related to this study continue. These sections include questions related to perceptions around malnutrition in EGS, current practices in identifying malnutrition and nutrition training and the future.

- Introduction and thanks
  - Background
  - *\*Discrete choice experiment\**
  - Perceptions around malnutrition in EGS
  - Current practices in identifying malnutrition
  - Nutrition training and the future
  - End and email request
- 
- Study 5
- Study 4

Questions were from a drop-down list, a 5-point Likert question-matrix with a 'do not know' option, or a selection of options from a menu. Instructions to 'select one' or 'select all that apply' were given as appropriate. Questions were adaptively formatted to explore responses further, with free text boxes also offered where appropriate. For the survey section, there were up to 8 questions per page displayed on 7 pages including the opening and closure pages; a progress bar was visible. Mandatory questions were indicated and participants were able to review answers until submission.

The full and final survey can be seen below, as can the user-interface seen by participants on a computer and a phone (**Additional File Figure 9** and **Additional File Figure 10**).

## Nutrition in Emergency General Surgery: Who Do We Feed?

---

Start of Block: Intro and thanks

Q1.1 Thank you for taking part in this study.

It takes approximately 15 minutes to complete. It is split into three sections.

- Questions about yourself. This will take 1 minute.
- Scenario-based questions. This will take 10 minutes.
- Questions about awareness, practice, barriers and training. This will take 3-5 minutes.

As a reminder, your responses will be anonymous. You will be able to leave this study and re-enter at a later time to finish it if required.

By pressing next, you are consenting to continue with the study.

End of Block: Intro and thanks

---

## Start of Block: Background

### Q2.1 Background



Q2.2 What is your current grade? Please select one from the drop down list.

- ☐ Consultant (1)
- ☐ ST7-8/ post-CCT fellow (2)
- ☐ ST3-6 (3)
- ☐ SAS doctor, associate specialist, trust grade (4)
- ☐ Other\_\_\_\_\_ (5)

Display This Question:

If Q2.2 = Other\_\_\_\_\_

Q2.3 If you selected 'other', please type your answer into the box here

---

---

---

---

---

Display This Question:

If Q2.2 = Consultant



Q2.4 Do you work in an intestinal failure unit?

- ☐ Yes (1)
- ☐ No (2)



Q2.5 Do you currently manage, or have previous experience of managing, patients on an intestinal failure unit?

- ☐ Yes (1)
- ☐ No (2)



Q2.6 What region do you currently work in? (drop down list)

- ☐ East Midlands (North) (1)
- ☐ East Midlands (South) (2)
- ☐ East of England (3)
- ☐ Ireland (4)
- ☐ Kent, Surrey & Sussex (5)
- ☐ North Central & East London (6)
- ☐ North West London (7)
- ☐ South London (South East) (8)
- ☐ South London (South West) (9)
- ☐ North East (10)
- ☐ North West (Mersey) (11)
- ☐ North West (North West) (12)
- ☐ Northern Ireland (13)
- ☐ Scotland (East - Dundee) (14)
- ☐ Scotland (North - Aberdeen) (15)
- ☐ Scotland (South East - Edinburgh) (16)
- ☐ Scotland (West - Glasgow) (17)
- ☐ South West (Peninsula) (18)
- ☐ South West (Severn) (19)
- ☐ Thames Valley (20)
- ☐ Wales (21)
- ☐ Wessex (22)
- ☐ West Midlands (23)
- ☐ Yorkshire & the Humber (24)

End of Block: Background

**\*At this point, the discrete choice experiment was inserted\***

Start of Block: Awareness, practice and barriers



Q5.1 Please indicate the extent to which you agree or disagree with the following statements

|                                                                                                                      | Strongly disagree<br>(1) | Disagree<br>(2)       | Neither agree nor disagree (3) | Agree<br>(4)          | Strongly agree (5)    | I do not know (6)     |
|----------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|--------------------------------|-----------------------|-----------------------|-----------------------|
| Malnutrition can significantly affect surgical outcomes. (1)                                                         | <input type="radio"/>    | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Identifying malnourished patients is an important skill for surgeons. (2)                                            | <input type="radio"/>    | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I screen and/ or assess for malnutrition in all emergency general surgical patients. (10)                            | <input type="radio"/>    | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I am confident I can identify all malnourished emergency surgical patients. (3)                                      | <input type="radio"/>    | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Surgeons are primarily responsible for <b>identifying</b> malnutrition in emergency surgical patients. (6)           | <input type="radio"/>    | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Surgeons are primarily responsible for <b>managing</b> malnutrition in emergency surgical patients. (7)              | <input type="radio"/>    | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| My organisation provides the support I need to identify and manage all malnourished emergency surgical patients. (8) | <input type="radio"/>    | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| The training which surgeons receive allows them to identify all malnourished emergency surgical patients. (9)        | <input type="radio"/>    | <input type="radio"/> | <input type="radio"/>          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |



Q5.2 Please indicate how often you undertake the following statements.

|                                                                                    | Never<br>(1)          | Rarely<br>(2)         | Occasionally<br>(3)   | Regularly<br>(4)      | Always<br>(5)         | I do not<br>know (6)  |
|------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I use evidenced-based practice when deciding a patient is malnourished. (2)        | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I seek help or advice from colleagues when deciding a patient is malnourished. (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Q5.1 = Malnutrition can significantly affect surgical outcomes. [ Strongly disagree ]

Or Q5.1 = Malnutrition can significantly affect surgical outcomes. [ Disagree ]

Or Q5.1 = Malnutrition can significantly affect surgical outcomes. [ Neither agree nor disagree ]



Q5.3 Why does malnutrition not significantly affect surgical outcomes? Please select all that apply.

- ☐ Surgical outcomes are not related to patients being malnourished (1)
- ☐ There is insufficient research or evidence in the literature supporting a link between malnutrition and surgical outcomes (2)
- ☐ Other factors are more important for patient outcomes such that malnutrition is not significant (3)
- ☐ I do not know (4)
- ☐ Other (5)

Display This Question:

If Q5.3 = Other

Q5.4 If you selected 'other', please type your answer into the box here

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Display This Question:

If Q5.1 = I screen and/ or assess for malnutrition in all emergency general surgical patients. [ Strongly disagree ]

Or Q5.1 = I screen and/ or assess for malnutrition in all emergency general surgical patients. [ Disagree ]

Or Q5.1 = I screen and/ or assess for malnutrition in all emergency general surgical patients. [ Neither agree nor disagree ]

X→

Q5.5 Why do you not routinely screen and/ or assess for malnutrition in emergency general surgical patients? Please select all that apply.

- ☐ Not part of my role (1)
- ☐ No time to screen or assess for malnutrition in an emergency surgery setting (2)
- ☐ Would not change immediate management (3)
- ☐ Lack of appropriate training (4)
- ☐ Lack of resources (eg dietitian to refer to or ask advice from) (5)
- ☐ I do not know (6)
- ☐ Other (7)

Display This Question:

If Q5.5 = Other

Q5.6 If you selected 'other', please type your answer into the box here

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Display This Question:

If Q5.1 = Surgeons are primarily responsible for <u><strong>identifying</strong></u> malnutrition in emergency surgical patients. [ Strongly disagree ]

Or Q5.1 = Surgeons are primarily responsible for <u><strong>identifying</strong></u> malnutrition in emergency surgical patients. [ Disagree ]

Or Q5.1 = Surgeons are primarily responsible for <u><strong>identifying</strong></u> malnutrition in emergency surgical patients. [ Neither agree nor disagree ]



Q5.7 You have indicated surgeons are not primarily responsible for identifying malnutrition in emergency surgical patients. Who is?

- ☐ Dietitian (1)
- ☐ The nutrition support team (NST) (2)
- ☐ Gastroenterologist (3)
- ☐ Pharmacist (4)
- ☐ Nutrition specialist nurse (5)
- ☐ I do not know (6)
- ☐ Other (7)

Display This Question:

If Q5.7 = Other

Q5.8 If you selected 'other', please type your answer into the box here

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Display This Question:

If Q5.1 = Surgeons are primarily responsible for <strong>managing</strong> malnutrition in emergency surgical patients. [ Strongly disagree ]

Or Q5.1 = Surgeons are primarily responsible for <strong>managing</strong> malnutrition in emergency surgical patients. [ Disagree ]

Or Q5.1 = Surgeons are primarily responsible for <strong>managing</strong> malnutrition in emergency surgical patients. [ Neither agree nor disagree ]



Q5.9 You have indicated surgeons are not primarily responsible for managing malnutrition in emergency surgical patients. Who is?

- ☐ Dietitian (1)
- ☐ The nutrition support team (NST) (2)
- ☐ Gastroenterologist (3)
- ☐ Pharmacist (4)
- ☐ Nutrition specialist nurse (5)
- ☐ I do not know (6)
- ☐ Other (7)

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*Display This Question:  
If Q5.9 = Other*

Q5.10 If you selected 'other', please type your answer into the box here

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Q5.11 How have you been trained to identify malnutrition in EGS patients? Please select all that apply.

- ☐ Medical school (1)
- ☐ Training course (2)
- ☐ Advice from or observation of a surgical colleague (3)
- ☐ Advice from the nutrition support team or another allied health professional (eg dietitian) (4)
- ☐ Learned from my previous patient cases (5)
- ☐ I do not know (6)
- ☐ Other (7)

---

*Display This Question:  
If Q5.11 = Other*

Q5.12 If you selected 'other', please type your answer into the box here

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Display This Question:

If Q5.1 = The training which surgeons receive allows them to identify all malnourished emergency surgical patients. [ Strongly disagree ]

Or Q5.1 = The training which surgeons receive allows them to identify all malnourished emergency surgical patients. [ Disagree ]

Or Q5.1 = The training which surgeons receive allows them to identify all malnourished emergency surgical patients. [ Neither agree nor disagree ]



Q5.13 How should nutritional assessment/ management training be improved? Please select all that apply.

- ☐ Specific teaching at medical school (1)
- ☐ A specific local or Deanery teaching session (2)
- ☐ A 1-2 day course aimed at surgeons in training (3)
- ☐ A postgraduate course (4)
- ☐ I do not know (5)
- ☐ Other (6)

Display This Question:

If Q5.13 = Other

Q5.14 If you selected 'other', please type your answer into the box here

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End of Block: Awareness, practice and barriers

### Start of Block: Identifying malnutrition

Display This Question:

If Q2.6 != Wales



Q6.1 How often do you use the following when determining a patient's nutritional status for the first time?

|                                                  | Never<br>(1)          | Rarely<br>(2)         | Occasionally<br>(3)   | Regularly<br>(4)      | All the<br>time (5)   | I do not<br>know (6)  |
|--------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Malnutrition Universal Screening Tool (MUST) (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Albumin (2)                                      | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Body mass index (3)                              | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Percentage weight loss over time (4)             | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Reduced oral intake *until now* (5)              | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Reduced oral intake *from now* (6)               | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| End of bed 'clinical' impression (12)            | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:  
If Q2.6 = Wales

X→

Q6.2 How often do you use the following when determining a patient's nutritional status for the first time?

|                                                                                                                               | Never<br>(1)          | Rarely<br>(2)         | Occasionally<br>(3)   | Regularly<br>(4)      | All the<br>time (5)   | I do not<br>know (6)  |
|-------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| All Wales Adult Nutritional Risk Screening Tool (weight; appetite; ability to eat; stress factor; pressure ulcer (WAASP)) (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Albumin (2)                                                                                                                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Body mass index (3)                                                                                                           | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Percentage weight loss over time (4)                                                                                          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Reduced oral intake *until now* (5)                                                                                           | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Reduced oral intake *from now* (6)                                                                                            | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| End of bed 'clinical' impression (12)                                                                                         | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

End of Block: Identifying malnutrition

Start of Block: Email request

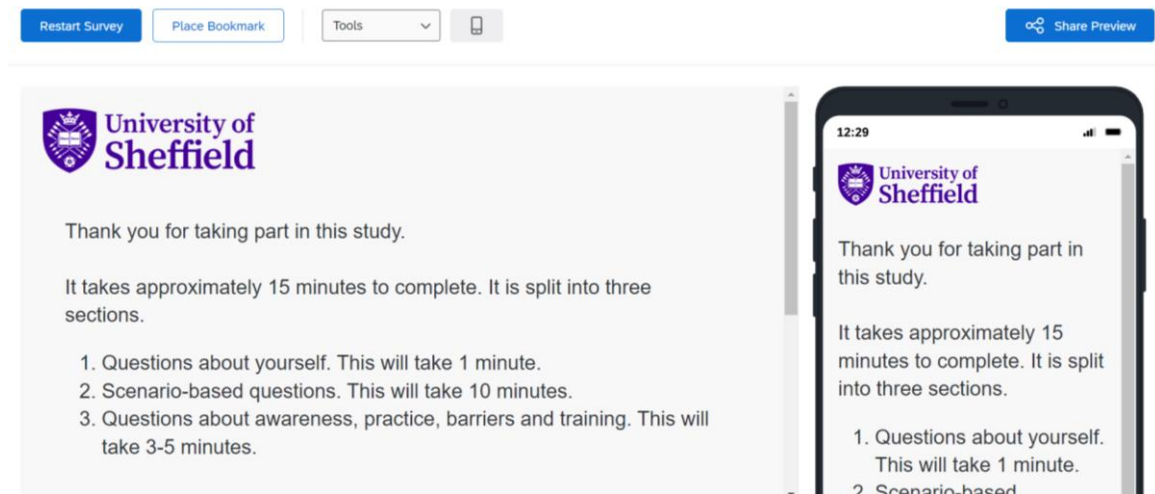
\*

Q7.1 If you would like to be kept informed regarding the findings of this study, any future studies relating to nutrition in emergency general surgery, or to avoid reminder emails to complete the above survey, please enter your email address below.

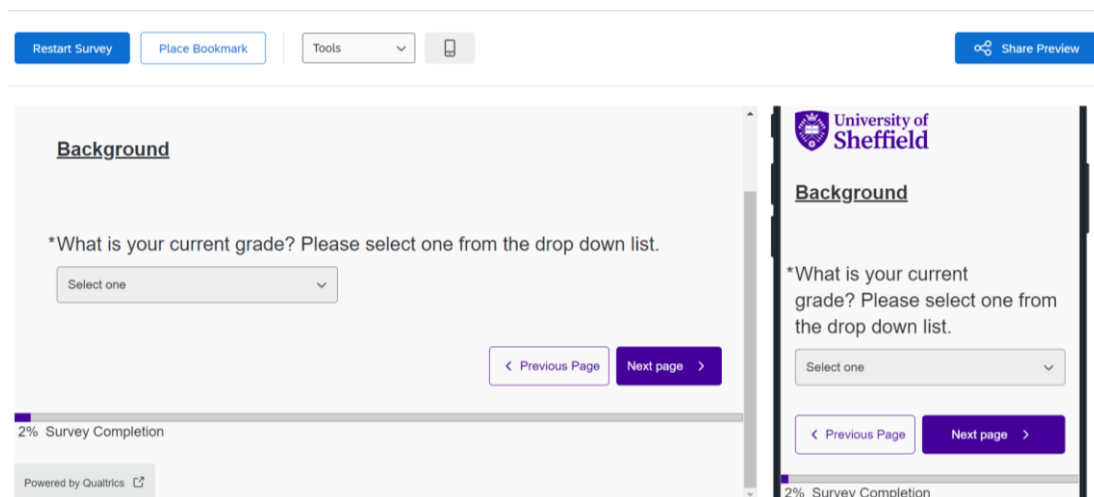
Your email address will NOT be linked to any of your answers in this study.

End of Block: Email request

## Study user interface



**Additional File Figure 9:** Computer and mobile phone views of the first page of studies 4 and 5



**Additional File Figure 10:** Computer and mobile phone views of studies 4 and 5 showing question 1

## Supplementary tables for Paper 4

**Table S28:** Association of participant response and experience of intestinal failure

| Question                                                                                                         | n   | U value | Effect size | IF experience median response | No IF experience median response | p value |
|------------------------------------------------------------------------------------------------------------------|-----|---------|-------------|-------------------------------|----------------------------------|---------|
| Malnutrition can significantly affect surgical outcomes.                                                         | 148 | 2927    | 0.110       | 5                             | 5                                | 0.182   |
| Identifying malnourished patients is an important skill for surgeons.                                            | 148 | 2945.5  | 0.090       | 5                             | 5                                | 0.273   |
| I screen and/ or assess for malnutrition in all emergency general surgical patients.                             | 148 | 3206    | 0.161       | 4                             | 4                                | 0.050*  |
| I am confident I can identify all malnourished emergency surgical patients.                                      | 148 | 3385.5  | 0.218       | 3                             | 3                                | 0.008*  |
| Surgeons are primarily responsible for <u>identifying</u> malnutrition in emergency surgical patients.           | 148 | 2611.5  | 0.039       | 4                             | 4                                | 0.637   |
| Surgeons are primarily responsible for <u>managing</u> malnutrition in emergency surgical patients.              | 148 | 3125.5  | 0.133       | 4                             | 4                                | 0.105   |
| My organisation provides the support I need to identify and manage all malnourished emergency surgical patients. | 148 | 3094.5  | 0.122       | 4                             | 4                                | 0.138   |
| The training which surgeons receive allows them to identify all malnourished emergency surgical patients.        | 148 | 3053    | 0.112       | 2                             | 2                                | 0.175   |
| I use evidenced-based practice when deciding a patient is malnourished.                                          | 148 | 3136.5  | 0.136       | 4                             | 3                                | 0.098   |
| I seek help or advice from colleagues when deciding a patient is malnourished.                                   | 148 | 2762.5  | 0.012       | 4                             | 4                                | 0.880   |
| MUST or WAASP                                                                                                    | 148 | 3797.5  | 0.347       | 4                             | 3                                | <0.001* |
| Albumin                                                                                                          | 148 | 2662    | 0.021       | 4                             | 4                                | 0.799   |
| Body mass index                                                                                                  | 148 | 2620.5  | 0.035       | 4                             | 4                                | 0.669   |
| Percentage weight loss over time                                                                                 | 148 | 3487    | 0.249       | 4                             | 3                                | 0.002*  |
| Reduced oral intake *until now*                                                                                  | 148 | 2601    | 0.046       | 5                             | 5                                | 0.579   |
| Reduced oral intake *from now*                                                                                   | 148 | 2473    | 0.089       | 4                             | 5                                | 0.279   |
| End of bed clinical impression                                                                                   | 148 | 2996.5  | 0.094       | 5                             | 5                                | 0.254   |

Surgeons with IF experience versus surgeons without IF experience. Significance determined by Mann Whitney U with  $p = <0.05$  deemed significant, unless otherwise stated.



**Table S29:** Association of participant response and surgeon seniority

| Question                                                                                                         | n   | U value | Effect size | Consultant median response | Non-consultant median response | p value |
|------------------------------------------------------------------------------------------------------------------|-----|---------|-------------|----------------------------|--------------------------------|---------|
| Malnutrition can significantly affect surgical outcomes.                                                         | 148 | 2788.0  | 0.028       | 5                          | 5                              | 0.738   |
| Identifying malnourished patients is an important skill for surgeons.                                            | 148 | 2642.0  | 0.039       | 5                          | 5                              | 0.637   |
| I screen and/or assess for malnutrition in all emergency general surgical patients.                              | 148 | 3255.0  | 0.173       | 4                          | 4                              | 0.035*  |
| I am confident I can identify all malnourished emergency surgical patients.                                      | 148 | 2965.0  | 0.075       | 3                          | 3                              | 0.361   |
| Surgeons are primarily responsible for <u>identifying</u> malnutrition in emergency surgical patients.           | 148 | 2600.5  | 0.047       | 4                          | 4                              | 0.572   |
| Surgeons are primarily responsible for <u>managing</u> malnutrition in emergency surgical patients.              | 148 | 2704.5  | 0.011       | 4                          | 4                              | 0.894   |
| My organisation provides the support I need to identify and manage all malnourished emergency surgical patients. | 148 | 3262.0  | 0.173       | 4                          | 3                              | 0.035*  |
| The training which surgeons receive allows them to identify all malnourished emergency surgical patients.        | 148 | 3022.0  | 0.097       | 2                          | 2                              | 0.240   |
| I use evidenced-based practice when deciding a patient is malnourished.                                          | 148 | 3099.0  | 0.120       | 4                          | 3                              | 0.146   |
| I seek help or advice from colleagues when deciding a patient is malnourished.                                   | 148 | 2614.5  | 0.041       | 4                          | 4                              | 0.617   |
| MUST or WAASP                                                                                                    | 148 | 3662.5  | 0.299       | 4                          | 2                              | <0.001* |
| Albumin                                                                                                          | 148 | 2781.0  | 0.014       | 4                          | 4                              | 0.862   |
| Body mass index                                                                                                  | 148 | 3201.0  | 0.155       | 4                          | 4                              | 0.060   |
| Percentage weight loss over time                                                                                 | 148 | 3609.0  | 0.284       | 4                          | 3                              | 0.001*  |
| Reduced oral intake *until now*                                                                                  | 148 | 2611.5  | 0.046       | 5                          | 5                              | 0.575   |
| Reduced oral intake *from now*                                                                                   | 148 | 2609.5  | 0.045       | 4                          | 5                              | 0.584   |
| End of bed clinical impression                                                                                   | 148 | 3050.0  | 0.108       | 5                          | 4                              | 0.189   |

Consultants versus non-consultants. Significance determined by Mann Whitney U with  $p = <0.05$  deemed significant, unless otherwise stated. BMI was also significant ( $p$  value = 0.050) across grades with Kruksall-Wallis.

**Table S30:** Reasons why screening for malnutrition is not performed all the time according to surgeon seniority and experience of intestinal failure

| Role                    | n  | Not part of my role | No time to screen or assess for malnutrition | Would not change immediate management | Lack of appropriate training | Lack of resources | I do not know | Other    |
|-------------------------|----|---------------------|----------------------------------------------|---------------------------------------|------------------------------|-------------------|---------------|----------|
| <i>Cons</i>             | 31 | 6.5 (2)             | 19.4 (6)                                     | 32.3 (10)                             | 16.1 (5)                     | 12.9 (4)          | 6.5 (2)       | 6.5 (2)  |
| <i>Non-cons</i>         | 58 | 6.9 (4)             | 20.7 (12)                                    | 27.6 (16)                             | 24.1 (14)                    | 12.1 (7)          | 3.4 (2)       | 5.2 (3)  |
| <i>IF experience</i>    | 31 | 6.5 (2)             | 19.4 (6)                                     | 22.6 (7)                              | 22.6 (7)                     | 12.9 (4)          | 3.2 (1)       | 12.9 (4) |
| <i>No IF experience</i> | 58 | 6.9 (4)             | 20.7 (12)                                    | 32.8 (19)                             | 20.7 (12)                    | 12.1 (7)          | 5.2 (3)       | 1.7 (1)  |
| <i>Total</i>            | 89 | 6.7 (6)             | 20.2 (18)                                    | 29.2 (26)                             | 21.3 (19)                    | 12.4 (11)         | 4.5 (4)       | 5.6 (5)  |

Responses as % (n). Abbreviations: cons (consultant); intestinal failure (IF); intestinal failure unit (IFU); non-cons (non-consultant); specialty and associate specialist (SAS); specialty trainee (ST). Note ST7-8 category also includes post-CCT fellows.

**Table S31:** Responsible person for identifying malnutrition in emergency surgical patients according to surgeon seniority and experience of intestinal failure

| Role                    | n  | Dietitian | Nutrition support team | Gastroenterologist | Pharmacist | Nutrition specialist nurse | I do not know | Other    |
|-------------------------|----|-----------|------------------------|--------------------|------------|----------------------------|---------------|----------|
| <i>Cons</i>             | 27 | 44.4 (12) | 29.6 (8)               | 0.0 (0)            | 0.0 (0)    | 3.7 (1)                    | 7.4 (2)       | 14.8 (4) |
| <i>Non-cons</i>         | 25 | 36.0 (9)  | 28.0 (7)               | 0.0 (0)            | 0.0 (0)    | 8.0 (2)                    | 0.0 (0)       | 28.0 (7) |
| <i>IF experience</i>    | 30 | 33.3 (10) | 40.0 (12)              | 0.0 (0)            | 0.0 (0)    | 3.3 (1)                    | 0.0 (0)       | 23.3 (7) |
| <i>No IF experience</i> | 33 | 45.5 (15) | 27.3 (9)               | 0.0 (0)            | 0.0 (0)    | 9.1 (3)                    | 9.1 (3)       | 9.1 (3)  |

Responses as % (n). Abbreviations: cons (consultant); intestinal failure (IF); intestinal failure unit (IFU); non-cons (non-consultant); specialty and associate specialist (SAS); specialty trainee (ST). Note ST7-8 category also includes post-CCT fellows.

**Table S32:** Responsible person for managing malnutrition in emergency surgical patients according to surgeon seniority and experience of intestinal failure

| Role                    | n  | Dietitian | Nutrition support team | Gastroenterologist | Pharmacist | Nutrition specialist nurse | I do not know | Other    |
|-------------------------|----|-----------|------------------------|--------------------|------------|----------------------------|---------------|----------|
| <i>Cons</i>             | 30 | 17.6 (6)  | 61.8 (21)              | 0.0 (0)            | 0.0 (0)    | 2.9 (1)                    | 5.9 (2)       | 11.8 (4) |
| <i>Non-cons</i>         | 29 | 34.5 (10) | 34.5 (10)              | 0.0 (0)            | 0.0 (0)    | 13.8 (4)                   | 6.9 (2)       | 10.3 (3) |
| <i>IF experience</i>    | 24 | 16.7 (4)  | 62.5 (15)              | 0.0 (0)            | 0.0 (0)    | 4.2 (1)                    | 4.2 (1)       | 12.5 (3) |
| <i>No IF experience</i> | 39 | 33.3 (13) | 41.0 (16)              | 0.0 (0)            | 0.0 (0)    | 7.7 (3)                    | 7.7 (3)       | 10.3 (4) |

Responses as % (n). Abbreviations: cons (consultant); intestinal failure (IF); intestinal failure unit (IFU); non-cons (non-consultant); specialty and associate specialist (SAS); specialty trainee (ST). Note ST7-8 category also includes post-CCT fellows.

**Table S33:** A summary of the free text comments regarding screening and assessment for malnutrition pre- and post-operatively

|                                                    | Comments                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Screening</b>                                   | <ul style="list-style-type: none"> <li>• Not required for all EGS patients</li> <li>• This is routine part of nursing admission with MUST score, which then triggers a review by dietitian team.</li> <li>• I assume that they are or are about to be malnourished</li> </ul>                                                                                                |
| <b>Responsibility for identifying malnutrition</b> | <ul style="list-style-type: none"> <li>• MUST score completed by nurses. Surgeons and nurses can refer to nutrition/dieticians. So surgeons are responsible as are other HCPs</li> <li>• We have a TPN team (made up of chemical pathologists) who do ward rounds and assess patients for TPN. They work closely with the surgical team and the dieticians.</li> </ul>       |
| <b>Managing malnutrition</b>                       | <ul style="list-style-type: none"> <li>• A team-based approach is required</li> <li>• I think this should be an MDT type approach with input from gastro and nutrition services</li> </ul>                                                                                                                                                                                   |
| <b>Training</b>                                    | <ul style="list-style-type: none"> <li>• Own private study for FRCS exams</li> <li>• Specialist training in surgical nutrition, IBD and IF surgery</li> <li>• Surgical training, NICE guidelines</li> <li>• Worked as a member of the nutrition team in a previous post</li> <li>• Fellowship</li> <li>• Have done ITU job</li> <li>• Discussions with dieticians</li> </ul> |
| <b>Improving nutrition training</b>                | <ul style="list-style-type: none"> <li>• Conferences and lectures/literature</li> <li>• Inter-specialty training - creating guidance and studies as currently or undertaken in the past (like NASBO e.g.) highlight the need of awareness</li> <li>• Courses designed for consultant level also</li> <li>• Online learning package focused for surgeons</li> </ul>           |

## Appendix 5

This section includes:

- Additional files to support Paper 5
  - **Additional File 1:** Research governance
  - **Additional File 2:** DCE development
  - **Additional File 3:** Final instrument
- Supplementary tables for Paper 5
  - **Table S34:** Preferences for nutritional support for each scenario according to surgeon seniority
  - **Table S35:** Preferences for nutritional support for each scenario for consultants
  - **Table S36:** Preferences for nutritional support for each scenario according to experience of intestinal failure

## Additional files to support Paper 5

### Additional file 1: Research governance

#### **Ethical approval**

This study was reviewed the University of Sheffield Medical School's Ethics Review Committee and approval was granted on 7<sup>th</sup> December 2022 (UREC 050436). NHS Research Ethics Committee approval was not required as the participants were NHS staff were recruited only by virtue of their profession.

#### **Informed consent**

Potential participants were invited by e-mail to read a Participant Information Sheet, the same as with study 4. This explained the purpose of the study, how data would be stored, the study investigators and the duration of the survey. It was explicit that their involvement in the study was voluntary, and who to contact if there were any issues.

Survey consent was implied by participants clicking on a link in the invitation email, and subsequently on another link agreeing to continue on the welcome page. Participants were advised they can withdraw from the survey up until submission of their survey form.

#### **Confidentiality**

Survey responses were anonymous. Participants were offered to be kept informed regarding the findings of this study, any future studies relating to nutrition in emergency general surgery, or to avoid reminder emails to complete the survey by providing an email address at the end of the survey. It was explained that their email address would not be linked to their responses. Databases were password protected and stored as per the data management plan.

## Additional file 2: DCE development

### Initial variable selection and mapping

Six variables which may influence outcome to start nutritional support were derived from relevant literature(50,301,316), informed by guidelines (43,98–101,107,109,353) and drawn from expert opinion of the study team (**Additional File Table 20**). These were developed and modified following these discussions (**Additional File Table 21**).



**Additional File Table 20:** Initial variable selection and mapping to previous studies and guidelines

| Variable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Level 1                                                  | Level 2                                | Level 3                                                                  | Level 4                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------|--------------------------------------------------------------------------|---------------------------------------------------------|
| <b>Diagnosis/ operation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Small bowel obstruction + conservative management</b> | Small bowel obstruction + adhesiolysis | Small bowel obstruction + small bowel resection + anastomosis (no stoma) | Small bowel obstruction + small bowel resection + stoma |
| <ul style="list-style-type: none"> <li>• Common emergency presentation with range of management options including surgery</li> <li>• Often malnourished to various degrees(50)</li> <li>• Frequently referred to diagnosis (study 3, interviews)</li> <li>• Surgical options include stoma or no stoma. This decision to join or not to join was a key subtheme from interviews, and seemed to be influenced by decision as to whether is malnourished or not</li> <li>• The decision for nutritional support seemed to be influenced by the nature of the surgery (interviews). Participants seemed more willing to observe (not refer for nutritional support) in conservatively Mx and adhesiolysis-only patients.</li> </ul> |                                                          |                                        |                                                                          |                                                         |
| <b>Albumin, g/L</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | < 20                                                     | 20.1-34.9                              | ≥35                                                                      |                                                         |
| <ul style="list-style-type: none"> <li>• Normal value taken from GLIM guidelines(94,101)</li> <li>• Common feature in study 1 (systematic review (#2)), study 2 (NELA survey (#1)) and study 3 (interviews) as indicator of malnutrition</li> <li>• Degree of hypoalbuminaemia appeared to drive decision making (study 3, interviews)</li> <li>• 'Common language' among surgeons for degree of malnutrition (study 3, interviews)</li> <li>• Not recommended by guidelines – potential for learning point if key attribute in DCE results</li> </ul>                                                                                                                                                                           |                                                          |                                        |                                                                          |                                                         |
| <b>BMI, Kg/m<sup>2</sup></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <18.5                                                    | ≥18.5-24.9                             | 25-29.9                                                                  | ≥30                                                     |
| <ul style="list-style-type: none"> <li>• Common feature in study 1 (systematic review (#2)), study 2 (NELA survey (#1)) and study 3 (interviews) as indicator of malnutrition</li> <li>• WHO criteria selected, which in part reflects recommendations in NICE(98) and GLIM guidelines(101) too</li> <li>• Increasing obesity trend in UK</li> <li>• Stud 3 (interviews) revealing polarised views of malnutrition in obese patients</li> </ul>                                                                                                                                                                                                                                                                                  |                                                          |                                        |                                                                          |                                                         |
| <b>Non-volitional weight loss, % in 3-6 months</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>0-4.9</b>                                             | 5-10                                   | >10                                                                      | -                                                       |
| <ul style="list-style-type: none"> <li>• Commonest component of screening tools in study 1 (systematic review), and featured in study 2 (NELA survey (#3)) and study 3 (interviews) as indicator of malnutrition</li> <li>• Percentage weight loss more important than absolute weight loss (study 3, interviews)</li> <li>• Features in all 3 tools recommended by GLIM(101) (NRS-2002, MNA-SF, MUST)</li> </ul>                                                                                                                                                                                                                                                                                                                |                                                          |                                        |                                                                          |                                                         |
| <b>Days <u>without</u> oral intake on admission</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>0</b>                                                 | 1-4                                    | ≥5                                                                       | -                                                       |
| <ul style="list-style-type: none"> <li>• Features in all 3 screening tools recommended by GLIM(101) (NRS-2002, MNA-SF, MUST)</li> <li>• Multiple participants from interviews used 'days without intake' phrase, recognising this includes pre-admission time frame</li> <li>• GLIM 'energy requirements' – not referenced in interviews(101). NICE terms 'little or nothing' more representative(98)</li> </ul>                                                                                                                                                                                                                                                                                                                 |                                                          |                                        |                                                                          |                                                         |
| <b>Days <u>unlikely to be</u> without oral intake</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>0</b>                                                 | 1-4                                    | ≥5                                                                       | -                                                       |
| <ul style="list-style-type: none"> <li>• Relevant to subthemes around clinical progress and planning ahead (interviews), and NICE guidelines ('...is likely to eat little or nothing for the next 5 days or longer')(98)</li> <li>• Partly relevant to need for early recognition of potential problem and referring for nutritional assessment and 'referral pathways' (study 2, NELA survey; study 3, interviews)</li> </ul>                                                                                                                                                                                                                                                                                                   |                                                          |                                        |                                                                          |                                                         |

**Additional File Table 21:** DCE study variable and level development summary

| Initial design                                        | Notable change                                                                                                                                                                                                                                                                                            | Reason for change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Diagnosis/ operation</b>                           | <ul style="list-style-type: none"> <li>SBO removed from variable and a clinical stem created: 'You are doing a ward round and reviewing this patient. It is day 3 since admission, and for relevant cases, it is post-operative day 1.'</li> <li>Variable name change to management/ operation</li> </ul> | <ul style="list-style-type: none"> <li>This will also allow for cases that would have had 'failed' conservative management for SBO, and more likely to be realistic to clinical practice</li> <li>Screening and assessment for malnutrition occurred more commonly post-operatively (study 2, NELA survey)</li> <li>Pathways exist to provide nutritional support post-operatively (study 2, NELA survey)</li> <li>Perceived lack of time and no change in immediate management when screening/ assessment done pre-operatively (stud 2, NELA survey; study 3; interviews)</li> </ul> |
| <b>Albumin</b>                                        | <ul style="list-style-type: none"> <li>Level change</li> </ul>                                                                                                                                                                                                                                            | <ul style="list-style-type: none"> <li>Equal split for albumin while addressing low and very low concepts</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>BMI</b>                                            | <ul style="list-style-type: none"> <li>No change</li> </ul>                                                                                                                                                                                                                                               | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Non-volitional weight loss</b>                     | <ul style="list-style-type: none"> <li>Variable name change to unintentional weight loss, % in 3-6 months</li> </ul>                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>'Non-volitional' unusual terminology for UK surgeons</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Days <u>without</u> oral intake on admission</b>   | <ul style="list-style-type: none"> <li>Variable name change to days without oral intake <i>until now</i></li> <li>Level change to 1-4, 5-6 or <math>\geq 7</math></li> </ul>                                                                                                                              | <ul style="list-style-type: none"> <li>Variable names clearer</li> <li>No patients with SBO will have 0 days without oral intake pre-or post-op, therefore this level is meaningless.</li> <li>Many participants from interviews recognised 7 days as a 'magic number' for starting nutritional support. Thus there needs to be a distinction between NICE recommended 5 days.</li> </ul>                                                                                                                                                                                             |
| <b>Days <u>unlikely to be</u> without oral intake</b> | <ul style="list-style-type: none"> <li>Variable name change days likely to be without oral intake <i>from now</i></li> <li>Level change to 1-4, 5-6 or <math>\geq 7</math></li> </ul>                                                                                                                     | <ul style="list-style-type: none"> <li>Consideration given to splitting 1-4 days but this will dramatically increase number of scenarios needed in final instrument</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                        |

## Additional file 3: Final instrument

### Nutrition in Emergency General Surgery: Who Do We Feed

---

#### Start of Block: Intro and thanks

Q1.1 Thank you for taking part in this study.

It takes approximately 15 minutes to complete. It is split into three sections. Questions about yourself. This will take 1 minute. Scenario-based questions. This will take 10 minutes. Questions about awareness, practice, barriers and training. This will take 3-5 minutes. As a reminder, your responses will be anonymous. You will be able to leave this study and re-enter at a later time to finish it if required.

By pressing next, you are consenting to continue with the study.

---

#### End of Block: Intro and thanks

---

#### Start of Block: Background

##### Q2.1 Background



Q2.2 What is your current grade? Please select one from the drop down list.

▼ Consultant (1) ... Other \_\_\_\_\_ (5)

---

*Display This Question:*

*If What is your current grade? Please select one from the drop down list. = 5*

Q2.3 If you selected 'other', please type your answer into the box here

---

---

---

*Display This Question:*

*If What is your current grade? Please select one from the drop down list. = 1*



Q2.4 Do you work in an intestinal failure unit?

☐ Yes (1)

☐ No (2)

---



Q2.5 Do you currently manage, or have previous experience of managing, patients on an intestinal failure unit?

☐ Yes (1)

☐ No (2)

---



Q2.6 What region do you currently work in?

▼ East Midlands (North) (1) ... Yorkshire & the Humber (24)

End of Block: Background

---

## Start of Block: Introduction to scenarios

Q3.1 This section comprises a series of 25 clinical scenarios on which you are asked to make a hypothetical decision about whether to start artificial nutritional support to meet the requirements of the patient or not. In all cases, the patient has adhesional small bowel obstruction and has been in hospital for 3 days. In relevant scenarios, it is the first day following their surgery. You are doing a ward round and reviewing the patient.

We are interested in the importance that you place on six factors influencing your decision to start artificial nutritional support or not. The scenarios are presented in a short tabulated format, varying with the following aspects:

### 1. Management/ operation

*Divided into the following:*

- Continue conservative management (Mx)
- Adhesiolysis
- Small bowel (SB) resection + stoma
- Small bowel (SB) resection + anastomosis

### 2. Albumin, g/L

*Divided into the following:*

- <25
- 25-29.9
- 30-34.9
- ≥35

### 3. Body mass index, Kg/m<sup>2</sup>

*Divided into the following:*

- <18.5
- 18.5-24.9
- 25-29.9
- ≥30

### 4. Unintentional weight loss, % in 3-6 months

*Divided into the following:*

- 0-4.9
- 5-10
- >10

### 5. Days without oral intake until now.

*This is defined as the number of days the patient has eaten little or nothing between symptom onset*

and your review now.

*Divided into the following:*

- 1-4
- 5-6
- $\geq 7$

**6. Days likely to be without oral intake from now.**

*This is defined as the number of days the patient will likely eat little or nothing from your review now.*

*Divided into the following:*

- 1-4
- 5-6
- $\geq 7$

End of Block: Introduction to scenarios

---

Start of Block: Scenarios

Q4.1

**Scenario 1**

|                                                       |                      |
|-------------------------------------------------------|----------------------|
| Management/ operation                                 | SB resection + stoma |
| Albumin, g/L                                          | ≥35                  |
| BMI, Kg/m <sup>2</sup>                                | 18.5-24.9            |
| Unintentional weight loss, % in 3-6 months            | 0-4.9                |
| Days without oral intake <u>until now</u>             | ≥7                   |
| Days likely to be without oral intake <u>from now</u> | 1-4                  |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.2

**Scenario 2**

|                                                       |                            |
|-------------------------------------------------------|----------------------------|
| Management/ operation                                 | SB resection + anastomosis |
| Albumin, g/L                                          | 30-34.9                    |
| BMI, Kg/m <sup>2</sup>                                | <18.5                      |
| Unintentional weight loss, % in 3-6 months            | 0-4.9                      |
| Days without oral intake <u>until now</u>             | 1-4                        |
| Days likely to be without oral intake <u>from now</u> | ≥7                         |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.3

**Scenario 3**

|                                                       |                                  |
|-------------------------------------------------------|----------------------------------|
| Management/ operation                                 | Continue conservative management |
| Albumin, g/L                                          | 30-34.9                          |
| BMI, Kg/m <sup>2</sup>                                | 25-29.9                          |
| Unintentional weight loss, % in 3-6 months            | 0-4.9                            |
| Days without oral intake <u>until now</u>             | ≥7                               |
| Days likely to be without oral intake <u>from now</u> | 1-4                              |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.4

**Scenario 4**

|                                                       |                            |
|-------------------------------------------------------|----------------------------|
| Management/ operation                                 | SB resection + anastomosis |
| Albumin, g/L                                          | <25                        |
| BMI, Kg/m <sup>2</sup>                                | ≥30                        |
| Unintentional weight loss, % in 3-6 months            | 0-4.9                      |
| Days without oral intake <u>until now</u>             | 5-6                        |
| Days likely to be without oral intake <u>from now</u> | 1-4                        |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.5

**Scenario 5**

|                                                       |                                  |
|-------------------------------------------------------|----------------------------------|
| Management/ operation                                 | Continue conservative management |
| Albumin, g/L                                          | <25                              |
| BMI, Kg/m <sup>2</sup>                                | <18.5                            |
| Unintentional weight loss, % in 3-6 months            | 0-4.9                            |
| Days without oral intake <u>until now</u>             | 1-4                              |
| Days likely to be without oral intake <u>from now</u> | 1-4                              |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.6

**Scenario 6**

|                                                       |                                  |
|-------------------------------------------------------|----------------------------------|
| Management/ operation                                 | Continue conservative management |
| Albumin, g/L                                          | 30-34.9                          |
| BMI, Kg/m <sup>2</sup>                                | 18.5-24.9                        |
| Unintentional weight loss, % in 3-6 months            | >10                              |
| Days without oral intake <u>until now</u>             | 5-6                              |
| Days likely to be without oral intake <u>from now</u> | 5-6                              |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.



Q4.7

**Scenario 7**

**Scenario 8**

|                                                       |              |
|-------------------------------------------------------|--------------|
| Management/ operation                                 | Adhesiolysis |
| Albumin, g/L                                          | 30-24.9      |
| BMI, Kg/m <sup>2</sup>                                | <18.5        |
| Unintentional weight loss, % in 3-6 months            | 5-10         |
| Days without oral intake <u>until now</u>             | 5-6          |
| Days likely to be without oral intake <u>from now</u> | 1-4          |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.8

Q4.9

**Scenario 9**

|                                                       |                      |
|-------------------------------------------------------|----------------------|
| Management/ operation                                 | SB resection + stoma |
| Albumin, g/L                                          | 25-29.9              |
| BMI, Kg/m <sup>2</sup>                                | <18.5                |
| Unintentional weight loss, % in 3-6 months            | 0-4.9                |
| Days without oral intake <u>until now</u>             | 1-4                  |
| Days likely to be without oral intake <u>from now</u> | 5-6                  |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.10

**Scenario 10**

|                                                       |              |
|-------------------------------------------------------|--------------|
| Management/ operation                                 | Adhesiolysis |
| Albumin, g/L                                          | <25          |
| BMI, Kg/m <sup>2</sup>                                | <18.5        |
| Unintentional weight loss, % in 3-6 months            | 5-10         |
| Days without oral intake <u>until now</u>             | ≥7           |
| Days likely to be without oral intake <u>from now</u> | 5-6          |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.11

**Scenario 11**

|                                                       |                            |
|-------------------------------------------------------|----------------------------|
| Management/ operation                                 | SB resection + anastomosis |
| Albumin, g/L                                          | ≥35                        |
| BMI, Kg/m <sup>2</sup>                                | 25-29.9                    |
| Unintentional weight loss, % in 3-6 months            | 5-10                       |
| Days without oral intake <u>until now</u>             | 1-4                        |
| Days likely to be without oral intake <u>from now</u> | 5-6                        |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.12

**Scenario 12**

|                                                       |                      |
|-------------------------------------------------------|----------------------|
| Management/ operation                                 | SB resection + stoma |
| Albumin, g/L                                          | <25                  |
| BMI, Kg/m <sup>2</sup>                                | <18.5                |
| Unintentional weight loss, % in 3-6 months            | 5-10                 |
| Days without oral intake <u>until now</u>             | 5-6                  |
| Days likely to be without oral intake <u>from now</u> | 1-4                  |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.13

**Scenario 13**

|                                                       |                                  |
|-------------------------------------------------------|----------------------------------|
| Management/ operation                                 | Continue conservative management |
| Albumin, g/L                                          | 25-29.9                          |
| BMI, Kg/m <sup>2</sup>                                | <18.5                            |
| Unintentional weight loss, % in 3-6 months            | >10                              |
| Days without oral intake <u>until now</u>             | 1-4                              |
| Days likely to be without oral intake <u>from now</u> | 1-4                              |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.14

**Scenario 14**

|                                                       |                                  |
|-------------------------------------------------------|----------------------------------|
| Management/ operation                                 | Continue conservative management |
| Albumin, g/L                                          | ≥35                              |
| BMI, Kg/m <sup>2</sup>                                | <18.5                            |
| Unintentional weight loss, % in 3-6 months            | 0-4.9                            |
| Days without oral intake <u>until now</u>             | 5-6                              |
| Days likely to be without oral intake <u>from now</u> | 5-6                              |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.15

**Scenario 15**

|                                                       |                            |
|-------------------------------------------------------|----------------------------|
| Management/ operation                                 | SB resection + anastomosis |
| Albumin, g/L                                          | 25-29.9                    |
| BMI, Kg/m <sup>2</sup>                                | 18.5-24.9                  |
| Unintentional weight loss, % in 3-6 months            | 5-10                       |
| Days without oral intake <u>until now</u>             | 5-6                        |
| Days likely to be without oral intake <u>from now</u> | 1-4                        |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.16

**Scenario 16**

|                                                       |              |
|-------------------------------------------------------|--------------|
| Management/ operation                                 | Adhesiolysis |
| Albumin, g/L                                          | <25          |
| BMI, Kg/m <sup>2</sup>                                | 18.5-24.9    |
| Unintentional weight loss, % in 3-6 months            | 0-4.9        |
| Days without oral intake <u>until now</u>             | 1-4          |
| Days likely to be without oral intake <u>from now</u> | ≥7           |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.17

**Scenario 17**

|                                                       |              |
|-------------------------------------------------------|--------------|
| Management/ operation                                 | Adhesiolysis |
| Albumin, g/L                                          | ≥35          |
| BMI, Kg/m <sup>2</sup>                                | ≥30          |
| Unintentional weight loss, % in 3-6 months            | >10          |
| Days without oral intake <u>until now</u>             | 1-4          |
| Days likely to be without oral intake <u>from now</u> | 1-4          |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.18

**Scenario 18**

|                                                       |                            |
|-------------------------------------------------------|----------------------------|
| Management/ operation                                 | SB resection + anastomosis |
| Albumin, g/L                                          | <25                        |
| BMI, Kg/m <sup>2</sup>                                | <18.5                      |
| Unintentional weight loss, % in 3-6 months            | >10                        |
| Days without oral intake <u>until now</u>             | ≥7                         |
| Days likely to be without oral intake <u>from now</u> | 5-6                        |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.19

**Scenario 19**

|                                                       |                                  |
|-------------------------------------------------------|----------------------------------|
| Management/ operation                                 | Continue conservative management |
| Albumin, g/L                                          | <25                              |
| BMI, Kg/m <sup>2</sup>                                | 18.5-24.9                        |
| Unintentional weight loss, % in 3-6 months            | 5-10                             |
| Days without oral intake <u>until now</u>             | 1-4                              |
| Days likely to be without oral intake <u>from now</u> | 5-6                              |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.20

**Scenario 20**

|                                                       |                      |
|-------------------------------------------------------|----------------------|
| Management/ operation                                 | SB resection + stoma |
| Albumin, g/L                                          | 30-34.9              |
| BMI, Kg/m <sup>2</sup>                                | ≥30                  |
| Unintentional weight loss, % in 3-6 months            | 5-10                 |
| Days without oral intake <u>until now</u>             | 1-4                  |
| Days likely to be without oral intake <u>from now</u> | 5-6                  |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.21

**Scenario 21**

|                                                       |                                  |
|-------------------------------------------------------|----------------------------------|
| Management/ operation                                 | Continue conservative management |
| Albumin, g/L                                          | <25                              |
| BMI, Kg/m <sup>2</sup>                                | 25-29.9                          |
| Unintentional weight loss, % in 3-6 months            | 5-10                             |
| Days without oral intake <u>until now</u>             | 1-4                              |
| Days likely to be without oral intake <u>from now</u> | 1-4                              |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.22

**Scenario 22**

| Management/ operation                                 | Continue conservative management |
|-------------------------------------------------------|----------------------------------|
| Albumin, g/L                                          | ≥35                              |
| BMI, Kg/m <sup>2</sup>                                | <18.5                            |
| Unintentional weight loss, % in 3-6 months            | 5-10                             |
| Days without oral intake <u>until now</u>             | 5-6                              |
| Days likely to be without oral intake <u>from now</u> | ≥7                               |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.23

**Scenario 23**

| Management/ operation                                 | Continue conservative management |
|-------------------------------------------------------|----------------------------------|
| Albumin, g/L                                          | 25-29.9                          |
| BMI, Kg/m <sup>2</sup>                                | ≥30                              |
| Unintentional weight loss, % in 3-6 months            | 5-10                             |
| Days without oral intake <u>until now</u>             | ≥7                               |
| Days likely to be without oral intake <u>from now</u> | ≥7                               |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.24

**Scenario 24**

| Management/ operation                                 | SB resection + stoma |
|-------------------------------------------------------|----------------------|
| Albumin, g/L                                          | <25                  |
| BMI, Kg/m <sup>2</sup>                                | 25-29.9              |
| Unintentional weight loss, % in 3-6 months            | >10                  |
| Days without oral intake <u>until now</u>             | 5-6                  |
| Days likely to be without oral intake <u>from now</u> | ≥7                   |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

Q4.25

**Scenario 25**

|                                                       |              |
|-------------------------------------------------------|--------------|
| Management/ operation                                 | Adhesiolysis |
| Albumin, g/L                                          | 25-29.9      |
| BMI, Kg/m <sup>2</sup>                                | 25-29.9      |
| Unintentional weight loss, % in 3-6 months            | 0-4.9        |
| Days without oral intake <u>until now</u>             | 5-6          |
| Days likely to be without oral intake <u>from now</u> | 5-6          |

Would you start artificial nutritional support to meet the requirements of this patient? Select one answer.

End of Block: Scenarios

**\*At this point, study 4 (survey) was inserted\***

## Supplementary tables for Paper 5

**Table S34:** Preferences for nutritional support for each scenario according to surgeon seniority

| Scenario           | Consultants      | Non-consultants  | ST7-8/ post-CCT fellow | ST3-6          | SAS doctor, associate specialist, trust grade |
|--------------------|------------------|------------------|------------------------|----------------|-----------------------------------------------|
| 1                  | 61.3 (46)        | 60.3 (44)        | 59.1 (13)              | 62.2 (23)      | 57.1 (8)                                      |
| 2                  | 96.0 (72)        | 95.9 (70)        | 100.0 (22)             | 97.3 (36)      | 85.7 (12)                                     |
| 3                  | 77.3 (58)        | 72.6 (53)        | 63.6 (14)              | 75.7 (28)      | 78.6 (11)                                     |
| 4                  | 73.3 (55)        | 65.8 (48)        | 59.1 (13)              | 67.6 (25)      | 71.4 (10)                                     |
| 5                  | 62.7 (47)        | 54.8 (40)        | 54.5 (12)              | 54.1 (20)      | 57.1 (8)                                      |
| 6                  | 93.3 (70)        | 90.4 (66)        | 86.4 (19)              | 94.6 (35)      | 85.7 (12)                                     |
| 7                  | 88.0 (66)        | 84.9 (62)        | 81.8 (18)              | 86.5 (32)      | 85.7 (12)                                     |
| 8                  | 70.7 (53)        | 58.9 (43)        | 63.6 (14)              | 56.8 (21)      | 57.1 (8)                                      |
| 9                  | 77.3 (58)        | 75.3 (55)        | 81.8 (18)              | 78.4 (29)      | 57.1 (8)                                      |
| 10                 | 100.0 (75)       | 97.3 (71)        | 95.5 (21)              | 100.0 (37)     | 92.9 (13)                                     |
| 11                 | 69.3 (52)        | 54.8 (40)        | 63.6 (14)              | 51.4 (19)      | 50.0 (7)                                      |
| 12                 | 76.0 (57)        | 72.6 (53)        | 77.3 (17)              | 73.0 (27)      | 64.3 (9)                                      |
| 13                 | 60.0 (45)        | 46.6 (34)        | 50.0 (11)              | 43.2 (16)      | 50.0 (7)                                      |
| 14                 | 90.7 (68)        | 84.9 (62)        | 90.9 (20)              | 83.8 (31)      | 78.6 (11)                                     |
| 15                 | 68.0 (51)        | 46.6 (34)        | 45.5 (10)              | 43.2 (16)      | 57.1 (8)                                      |
| 16                 | 92.0 (69)        | 89.0 (65)        | 86.4 (19)              | 91.9 (34)      | 85.7 (12)                                     |
| 17                 | 18.7 (14)        | 11.0 (8)         | 13.6 (3)               | 10.8 (4)       | 7.1 (1)                                       |
| 18                 | 100.0 (75)       | 97.3 (71)        | 100.0 (22)             | 100.0 (37)     | 85.7 (12)                                     |
| 19                 | 81.3 (61)        | 75.3 (55)        | 81.8 (18)              | 75.7 (28)      | 64.3 (9)                                      |
| 20                 | 58.7 (44)        | 57.5 (42)        | 68.2 (15)              | 56.8 (21)      | 42.9 (6)                                      |
| 21                 | 34.7 (26)        | 23.3 (17)        | 22.7 (5)               | 18.9 (7)       | 35.7 (5)                                      |
| 22                 | 98.7 (74)        | 98.6 (72)        | 100.0 (22)             | 97.3 (36)      | 100.0 (14)                                    |
| 23                 | 96.0 (72)        | 100.0 (73)       | 100.0 (22)             | 100.0 (37)     | 100.0 (14)                                    |
| 24                 | 100.0 (75)       | 98.6 (72)        | 100.0 (22)             | 97.3 (36)      | 100.0 (14)                                    |
| 25                 | 80.0 (60)        | 82.2 (60)        | 86.4 (19)              | 81.1 (30)      | 78.6 (11)                                     |
| Overall preference | 77.7 (1443/1875) | 71.8 (1310/1825) | 73.3 (4.3/550)         | 71.9 (665/925) | 69.1 (242/350)                                |

Consultant preference as reference value. Red =  $\geq 5\%$  below reference value; green  $\geq 5\%$  above reference value.



**Table S35:** Preferences for nutritional support for each scenario for consultants

| Scenario           | Work in IFU    | Do not work in an IFU |
|--------------------|----------------|-----------------------|
| 1                  | 60.0 (6)       | 61.5 (40)             |
| 2                  | 100.0 (10)     | 95.4 (62)             |
| 3                  | 80.0 (8)       | 76.9 (50)             |
| 4                  | 70.0 (7)       | 73.8 (48)             |
| 5                  | 80.0 (8)       | 60.0 (39)             |
| 6                  | 90.0 (9)       | 93.8 (61)             |
| 7                  | 90.0 (9)       | 87.7 (57)             |
| 8                  | 70.0 (7)       | 70.8 (46)             |
| 9                  | 70.0 (7)       | 78.5 (51)             |
| 10                 | 100.0 (10)     | 100.0 (65)            |
| 11                 | 100.0 (10)     | 64.6 (42)             |
| 12                 | 80.0 (8)       | 75.4 (49)             |
| 13                 | 60.0 (6)       | 60.0 (39)             |
| 14                 | 90.0 (9)       | 90.8 (59)             |
| 15                 | 70.0 (7)       | 67.7 (44)             |
| 16                 | 100.0 (10)     | 90.8 (59)             |
| 17                 | 20.0 (2)       | 18.5 (12)             |
| 18                 | 100.0 (10)     | 100.0 (65)            |
| 19                 | 90.0 (9)       | 80.0 (52)             |
| 20                 | 70.0 (7)       | 56.9 (37)             |
| 21                 | 50.0 (5)       | 32.3 (21)             |
| 22                 | 100.0 (10)     | 98.5 (64)             |
| 23                 | 100.0 (10)     | 95.4 (62)             |
| 24                 | 100.0 (10)     | 100.0 (65)            |
| 25                 | 80.0 (8)       | 80.0 (52)             |
| Overall preference | 80.8 (202/250) | 76.4 (1241/1625)      |

Work in IFU preference as reference value. Red =  $\geq 5\%$  below reference value; green  $\geq 5\%$  above reference value.

**Table S36:** Preferences for nutritional support for each scenario according to experience of intestinal failure

| Scenario           | IF experience    | No IF experience |
|--------------------|------------------|------------------|
| 1                  | 60.9 (42)        | 60.8 (48)        |
| 2                  | 98.6 (68)        | 93.7 (74)        |
| 3                  | 72.5 (50)        | 77.2 (61)        |
| 4                  | 66.7 (46)        | 72.2 (57)        |
| 5                  | 66.7 (46)        | 51.9 (41)        |
| 6                  | 94.2 (65)        | 89.9 (71)        |
| 7                  | 85.5 (59)        | 87.3 (69)        |
| 8                  | 62.3 (43)        | 67.1 (53)        |
| 9                  | 76.8 (53)        | 75.9 (60)        |
| 10                 | 98.6 (68)        | 98.7 (78)        |
| 11                 | 65.2 (45)        | 59.5 (47)        |
| 12                 | 75.4 (52)        | 73.4 (58)        |
| 13                 | 58.0 (40)        | 49.4 (39)        |
| 14                 | 87.0 (60)        | 88.6 (70)        |
| 15                 | 60.9 (42)        | 54.4 (43)        |
| 16                 | 92.8 (64)        | 88.6 (70)        |
| 17                 | 15.9 (11)        | 13.9 (11)        |
| 18                 | 98.6 (68)        | 98.7 (78)        |
| 19                 | 81.2 (56)        | 75.9 (60)        |
| 20                 | 62.3 (43)        | 54.4 (43)        |
| 21                 | 33.3 (23)        | 25.3 (20)        |
| 22                 | 100.0 (69)       | 97.5 (77)        |
| 23                 | 98.6 (68)        | 97.5 (77)        |
| 24                 | 100.0 (69)       | 98.7 (78)        |
| 25                 | 79.7 (55)        | 82.3 (65)        |
| Overall preference | 75.7 (1305/1725) | 73.3 (1448/1975) |

IF experience preference as reference value. Red =  $\geq 5\%$  below reference value; green  $\geq 5\%$  above reference value.

## Appendix 6

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**Matthew Lee** 20:51 (23 minutes ago) ☆ ↶ ⋮  
to me ▼

Dear Dan

I confirm that I am happy for you to reproduce work arising from your PhD studies on malnutrition and emergency surgery within your thesis, and acknowledge your leading role on these materials.

Matt

Mr Matthew Lee PhD FRCS  
BHP Clinician Scientist & Honorary Consultant Colorectal Surgeon  
University of Birmingham & University Hospitals Birmingham

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**Vanessa Halliday** 08:58 (2 hours ago) ☆ ↶ ⋮  
to me ▼

Dear Danny

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With all good wishes,  
Vanessa

Vanessa Halliday SFHEA, PhD, RNutr (Public Health), RD  
Faculty Director of Education for Health  
Senior University Teacher, School of Medicine and Population Health, University of Sheffield  
Regent Court, 30 Regent Street  
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Best wishes,

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## Interview reproducing statement External Inbox x



**Daniel Baker**

08:31 (3 hours ago) ☆ ↩ ⋮

to me ▾

Hi Dan,

I'm happy for you to reproduce work from the interviews conducted on malnutrition that I was a co-author on with yourself as lead author.

Thanks,  
Danny

**Daniel Baker MRCS MBChB(Hons) BMedSci(Hons) PGCert**

General Surgery Registrar, Yorkshire and Humber

M: 07787013968 | Twitter: @dmbaker13

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**Jenna L Morgan**

Fri, 27 Sept, 13:52 (1 day ago) ☆ ↩ ⋮

to me ▾

Hi Danny,

I can confirm I am happy for you to reproduce in full any work relating to the Discrete Choice Experiment we co-authored together to determine "What influences emergency general surgeons' treatment preferences for patients requiring nutritional support?"

BW

Jenna  
Jenna Morgan

NIHR Advanced Fellow, University of Sheffield Medical School, Beech Hill Road, Sheffield, S10 2RX

Honorary Consultant Oncoplastic Breast Surgeon, Doncaster and Bassetlaw Teaching Hospitals NHS Trust

## Permission from Jenna Morgan

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