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Implementation and Evaluation of a Patient Completed Pre-operative Assessment Questionnaire

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List of abbreviations

POA	Preoperative assessment
STH	Sheffield Teaching Hospitals NHS Foundation Trust
NHS	National Health Service
ePAQ	electronic Personal Assessment Questionnaire
ePAQ-PO	ePAQ Pre-Operative
ePAQ-PF	ePAQ Pelvic Floor
PONV	Post operative nausea and vomiting
NICE	National institute of healthcare and clinical excellence
ITU	Intensive therapy unit
QoL	Quality of life
PDA	Personal digital assistant
ASA	American association of anaesthesiologists
SN	Staff nurse
NP	Nurse practitioner
HCA	Health care assistant
RHH	Royal Hallamshire Hospital
NGH	Northern General Hospital
MeSH	Medical Subject Headings
EuSoS	European study of outcomes following elective surgery
CPET/CPEX	Cardiopulmonary exercise testing
ISWT	Incremental shuttle walk test
DASI	Duke activity status index

1 Summary

A large number of validated questionnaires and risk assessment scores are used in modern clinical practice. Questionnaires are used for a range of purposes that include; research, symptom and disease assessment, outcome prediction, service evaluation and patient satisfaction surveys. Manually processing paper-based questionnaires can be time consuming, costly and inevitably introduces data errors. Paper-based questionnaires can also present a significant burden to the patients and preoperative assessment staff. Computerised versions have been developed with the aim of reducing burden and increasing the quality and value of the collected data. There is also the potential for the information to be processed at the point of data entry and for validated algorithms to be used to determine appropriate resource allocation and ongoing management pathways.

Anaesthetic pre-operative assessment is an essential step in the surgical patient care pathway. This process improves patient safety and the efficiency of care delivery. Anaesthetic pre-operative assessment frequently involves the completion of lengthy and complex paper questionnaires. This project examines whether a computerised version of these questionnaires could be developed and if introduced into clinical practice, whether it would improve efficiency and be acceptable to patients.

This project reports the process of developing and validating a computerised pre-operative assessment questionnaire: electronic Personal Assessment Questionnaire Pre-Operative (ePAQ-PO). It then makes an assessment of the impact that this questionnaire could have on the pre-operative anaesthetic assessment services at Sheffield Teaching Hospitals NHS Foundation Trust.

It is anticipated that, once implemented, the patient data collected by ePAQ-PO could be linked to outcomes and that regression analysis may identify factors which pre-dispose to adverse patient outcomes.

2 Introduction

Anaesthetic pre-operative assessment or review (PO-A) is vital to ensure safe surgery. Much of PO-A used to take place the night before surgery or, less commonly, by special arrangement with the anaesthetist involved. In recent years, efficiency drives within the NHS have led to more patients being admitted on the day of surgery (1). PO-A has therefore become mandatory for all patients prior to admission (2). Failure to undertake proper patient assessment has been associated with an increased risk of peri-operative morbidity, mortality and day of surgery cancellations (3). At Sheffield Teaching Hospitals NHS Foundation Trust (STH), and many other hospitals, PO-A is now performed centrally (4). Pre-operative assessment units are often staffed by multidisciplinary teams comprising; specialist nurses, health care assistants, administrative teams and consultant anaesthetists. Pre-operative anaesthetic assessment arrangements for NHS patients present a huge challenge to healthcare providers. Inappropriate or untimely appointments are burdensome, costly and wasteful of limited resources. Specialist, highly qualified staff perform tasks that could be easily be performed by less specialist (lower paid) staff. The use of an electronic pre-operative assessment questionnaire may facilitate better use of staff resources and enable better matching of tasks through a system of automated data collection and triage.

The 2010 UK Government Spending Challenge prompted a review of pre-operative anaesthetic assessment, performed by the Quality, Innovation, Productivity and Prevention (QIPP) digital function within Connecting for Health. At the time of the review no centres in the UK were using patient completed anaesthetic pre-operative assessment.

This project sought to develop a valid, reliable and acceptable anaesthetic pre-operative assessment questionnaire, introduce it into clinical practice and make an assessment of its impact and acceptability.

3 Literature Review

This review examines the literature surrounding the development, evaluation and implementation of electronic, patient completed pre-operative health assessment questionnaires.

3.1 Method of review

The literature search was performed, at the outset of this project in 2013, using Google Scholar, Pubmed and Ovid. A systematic search of the literature, published in the English language, was conducted using the search headings shown in table 1. The references of key papers were cross-referenced and examined in order to identify other relevant publications that were not highlighted by the initial search terms.

Table 1 Terms used for literature search

Computerised	Touch-screen	Health assessment	NICE
Computerized	Touchscreen	Electronic	Triage
Pre-operative	Anaesthetic	Pre-assessment	Peri-operative
Preoperative	Anaesthesia	Investigations	Perioperative
Patient completed	Quality of life	Guidelines	Risk

These words were used in various combinations and sequences to identify relevant publications in 2013

These search terms were used in different combinations when searching the literature. Table 2 shows the number of articles that contained the search terms within their titles.

Table 2 The number of articles found for key search terms.

	All dates	2009 to 2013
Computerised Health assessment	8	2
Preoperative assessment questionnaire	12	4
Patient completed preoperative assessment	0	0
Computerised preoperative assessment	0	0
Computerized preoperative assessment (z)	15	4
Anaesthetic preoperative assessment	10	6
Anaesthetic risk assessment	1	1
Surgical risk	3,100	1,200
Surgical risk assessment	155	70
Surgical risk prediction	46	26
Anaesthetic preoperative assessment questionnaire	0	0
Health assessment questionnaire	451	136
Patient completed health assessment questionnaire	1	1
Computerized health assessment	26	7
Computerized health assessment questionnaire	2	2

The spelling of the word computerised/computerized affected the success of the search significantly. Of the 15 articles found relating to “Computerized” Preoperative Assessment, 9 related to computerised tomography (CT), 4 related to computerised patient questionnaires and 1 related to computerised intra-operative anaesthesia records and only 2 involved a computerised model questionnaire for preoperative risk assessment.

There have been significant advances in mobile computer technology since 2009 but the literature search did not support the assumption that this would be associated with a significant increase in work developing and validating computerised patient questionnaires. It is possible that the search terms used were too restrictive and the search was limited to the exact phrase. Adjusting the search to allow flexibility in word sequence, include foreign languages and use standardised Medical Subject Headings (MeSH) terms may have yielded a greater number of responses.

At the time of completing the literature search the main focus was on identifying whether computerised pre-operative assessment questionnaires had been developed. As a result of this I focused on papers that predicted risk. Including terms such as “outcome” may have identified more papers and helped to identify key items which predict poor post-operative outcome.

One publication was found which described patient completed questionnaires that were being used in pre-operative assessment clinics in Canada (5). Another paper published in 2011 reported the validation of a computerised screening questionnaire. This Dutch questionnaire comprised 22 questions and used the patients’ responses to assign American Society of Anaesthesia (ASA) scores (6).

3.2 Quality of life measurement

The intended outcome of most health care interventions is an improvement in Quality of Life (QOL). The majority of validated patient questionnaires therefore relate to QOL. The papers describing the development and validation of these questionnaires provided a useful guide for the design of this study. Various groups had arranged batteries of questions forming general QOL questionnaires, pain assessment tools or disease specific symptom checklists. A selection of those that were found during the literature search are listed here:

Table 3 Commonly used quality of life assessment questionnaires

Name	Description
Body Image Scale (7)	Scale evaluating the disfiguring effects of surgery and late effects of radiotherapy
Brief Pain Inventory (8)	Self-reported measure assessing pain, its severity and disruptive effect
FACIT Fatigue Scale (9)	13 item list examining psychological components of fatigue
General Health Questionnaire (10)	12 item self-report measure. Examines common symptoms of clinical disorder
SF-36 (11)	36 item measure, evaluating multidimensional aspects of health and pain

References refer to either the questionnaire or a mention of the device

In assessing the appropriateness of any quality of life measure it is important to consider the patient group that will be using it, the disease process being monitored and the properties of the questionnaire itself. Questionnaires are assessed in terms of content validity, internal consistency, criterion validity, construct validity, reproducibility (agreement and reliability), responsiveness, floor and ceiling effects and interpretability (12).

3.3 PROMs

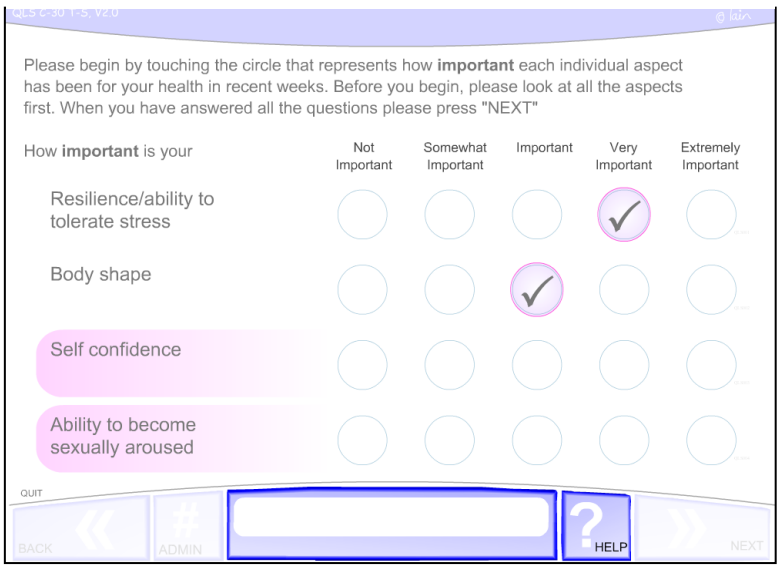
Patient reported outcome measures (PROMs) are questionnaires that patients complete after receiving medical treatment. They are validated measures, which are often specific to the intervention that the patient underwent. PROMS are intended to measure whether the intervention has resulted in a change in symptoms and QOL, they may be disease specific or more general. Patients have an increased amount of choice and can use this data to guide them when choosing which health care provider they intend to use. PROMS data is used by NHS commissioners and regulatory organisations in order to ensure that adequate standards are being maintained. They are also used to compare interventions and assess the effectiveness of new techniques. In the UK PROMS are used to assess the outcomes after hip replacement, knee replacement, groin hernia and varicose vein surgery.

There are many limitations with PROMS and challenges with establishing valid and generalisable scoring systems. Lengthy PROMS questionnaires risk degradation of data quality as a result of patient fatigue. There is a move to develop shorter versions that are easier to complete and therefore more likely to be accurate. Another limiting factor is the significant cost associated with distributing and collating paper questionnaires (13). If electronic pre-operative assessment questionnaires are adopted into routine use they could be adapted and include baseline PROMS questions.

3.4 Electronic patient completed systems

The conversion of paper-based questionnaires to computerised formats has been performed for many years. There are a variety of forces that have driven this, the need for increased accessibility, standardisation, interactivity and efficiency. Many studies exist demonstrating the comparability of computerised and paper formats (5, 14). The computerisation of questionnaires has been shown to be acceptable to patients and reduce the errors that occur when scoring questionnaire data (15). Computerised questionnaires have been developed and validated with a wide age range of patients. Acceptability and patient compliance is affected by the technology that is used.

Figure 1 A Screen shot from a touch-screen quality of life questionnaire



Computerisation of questionnaires has been shown to be particularly suited to complex or potentially embarrassing questionnaires (16-18). Patients may be more willing to interact with a computer, rather than reveal personal facts to another individual. Velicova demonstrated that there is a high level of concordance between QOL questionnaires and clinical notes (19), and that specific computerised patient-reported QOL questionnaires can provide more detailed symptom and functional status information (20). Bourgeois et all demonstrated that patient-reported data was superior to diagnostic coding data when used for disease surveillance in Emergency Departments (21).

A Danish study in 2007 (22) demonstrated that electronic questionnaires have a greater uptake than paper questionnaires and can provide immediate feedback and data interpretation. It also demonstrated that by enhancing the questionnaire with interactivity, specific patient/carer groups can be targeted and asked more detailed questions depending on their responses to previous questions. Not only does this provide more in-depth information, but it also enhances patient satisfaction.

The routine use of QOL measures is common in clinical oncology. Computerisation of the questionnaires and staff education facilitate their

uptake, improve data quality and make their use more feasible (23, 24). Staff education is as important as patient education as the uptake of novel technology can be hampered if clinical and clerical staff do not recognise the value of the electronic questionnaire and do not support its introduction (25).

The selection of hardware is also important when constructing a computerised survey and initial start-up costs can present a barrier to the introduction of computerised questionnaires. Kvien demonstrated that patients with rheumatoid arthritis achieve similar completion times and make a comparable number of errors when using either a traditional paper and pen questionnaires or an inexpensive personal digital assistant (PDA) (26). In an American comparison of PDA technology and paper the authors found that the error rate for computerised data was lower (3% vs 35%). Streiner and Norman report the typical error rate for paper questionnaires to be between 5 and 10% (27) computer technology, this exceeds the error rate in computer systems. Despite the increased error rate, the response rate for the paper questionnaires was greater (94% vs 82%) (28). This increased response rate in paper questionnaires was attributed to technical difficulties, institutional firewalls and theft of devices. The authors acknowledged that the response rate for the paper questionnaires in this study was unusually high. This may have been because patients were particularly motivated to complete the questionnaire that related specifically to their health problems and helped them express their symptoms. Despite the relatively poor response rate of electronic questionnaire completion the authors concluded that, with the advent of improved web based survey technologies which will overcome many of the technical problems encountered and the lower error rate, computerised questionnaires will become increasingly viable.

Basch et al successfully used a web based platform to collect outcome data from chemotherapy trial patients, although the rate of uptake of the computer system was influenced by prior computer use (29). Age however, does not appear to predict preference for or against computerised touch-screen systems, although it does influence the ease of use. Eillo et all found that breast cancer patients undergoing mammography were more likely to find the touch-

screen questionnaire easy to use if they were less than 65yrs of age (30). It would appear that touch-screen technology can reduce the negative impact that increased age and limited prior computer experience can have on the uptake of computerised questionnaires (31). A significant learning effect is seen when computerised QOL measures are used on repeated occasions (32).

Touch screen technology is also used to give information. The effectiveness of these systems is dependent on a number of factors including location, formatting of the text, the content and also the end user (33).

3.5 Criticisms of electronic completion

Concerns have been raised over the use of computer technology in questionnaire completion. These include the cost of custom made electronic data capture devices and the inherent redundancy as technology, scripting language and communication protocols change. More versatile devices are prone to theft and accidental damage. Over recent decades there has been an increase in cybercrime with data being frozen or stolen for commercial or malicious purposes. This has created a fear over data security and patient confidentiality. Data governance rules intended to protect personal data present significant challenges to the maintenance of secure but usable databases. These challenges include the need to be able to communicate across secure firewalls and maintain data in an anonymised format while still being able to ensure that it can be matched to the correct patient. The cost of developing and validating computerised questionnaires far exceeds the cost of printing and distributing small numbers of paper questionnaires. However, the cost-benefit balance is affected by economies of scale and the degree by which a questionnaire platform can be modified and personalised.

At the time of initiating this study one of the limiting factors in questionnaire adoption was the cost incurred by health care institutions when purchasing and installing touch screen computer devices. However, in the time interval between initiating this work and completing this thesis there has been a near exponential growth in the availability of touch-screen devices. Many households now own

multiple touch screen computer devices or smartphones that enable patients to complete a questionnaire on their own devices.

3.6 Pre-operative assessment

It is considered standard practice for the anaesthetist to see the patient before the patient arrives in the anaesthetic room, “advanced pre-operative anaesthetic review” (APOAR). This allows problems to be anticipated or clarified and a discussion to take place, which facilitates informed consent. This meeting has been shown to influence clinical management in 15% of cases and to improve patient satisfaction (34).

The benefits of pre-operative assessment and the advantages of seeing the patient well in advance of the anticipated surgery were recognised by R Mackenzie in 1931 (35). APOAR has been shown to increase the rate of same day admissions, reduce the length of stay, reduce the number of post-operative ITU days and reduce the incidence of cancellations occurring on the day-of-surgery (36). These findings were confirmed by a two year review of a pre-operative assessment service at the John Radcliffe Hospital, Oxford (37). This reduction in day-of-surgery cancelations was achieved largely by the early identification, investigation and treatment of uncontrolled hypertension and cardiovascular or respiratory instability. The avoidance of day-of-surgery cancellations has been demonstrated even when APOAR occurs only 24hrs prior to surgery (38). However, the reduction of day-of-surgery cancellations when APOAR occurs within the preceding 24 hrs may only be of limited benefit as there may not be enough time to find another case to fill the operating theatre list or alternatively implement therapy that sufficiently optimises the patient for theatre. Therefore, in most situations APOAR should be planned well in advance of surgery and preferably soon after the decision to operate has been made.

APOAR is increasingly performed in dedicated clinics by specially trained nursing staff with input from consultant anaesthetic staff (39, 40), usually under the auspices of the anaesthetic department. Anaesthetic pre-operative assessment performed in advance of the day of surgery has the primary aim of

improving patient safety (41). In a survey of 1850 delegates at the 2005 Annual meeting of American Society of Anaesthesiologists it was thought that delays occurred in 10% of patients who had not undergone pre-operative assessment (42). However APOAR does not guarantee that cancellation will not occur as the health status of a patient may change or the responsible anaesthetist on the day of surgery may disagree with the assessment of the pre-operative assessment clinic (37). The strength of evidence supporting the pre-operative assessment process is such that many national guidelines world-wide support their introduction (2, 43). Many pre-operative assessment clinics see 50 or more patients per day and it has been proposed that triage systems may be introduced in order to increase their efficiency (44). The involvement of anaesthetists also varies from clinic to clinic, some seeing all patients directly, some when the patient has been specifically identified as high risk, and some only reviewing the information after the patient has left the assessment clinic. There is significant national variation in clinic design and function.

Table 4 Typical questions that are asked during pre-operative assessment

Typical questions
Have you ever had an anaesthetic?
Were there any problems related to the anaesthetic?
Do you have any medical problems?
Are you on any regular medications?
Do you have problems with acid reflux?
Do you have any allergies to any medications?
Do you ever get chest pain or shortness of breath?
Do you get short of breath climbing stairs?
Do you have any dentures or loose teeth, caps or crowns?
When did you last have anything to eat or drink?

Adapted from (45)

3.7 Pre-operative anxiety and information exchange

The pre-operative assessment process serves a greater function than simple health screening. Information giving, patient education and addressing patient concerns is a core function. Increased knowledge of the anaesthetic process is associated with reduced levels of anxiety (46). The pre-operative assessment clinic also provides a valuable opportunity for patient education and addressing specific patient fears (45). The anaesthetist can ask further questions and clarify specific health issues as well as discuss the advantages and disadvantages of having surgery and the chosen anaesthetic technique. At times, it may be decided that it is not appropriate for the planned surgery to take place. This may be because of patient preference or because the anaesthetist decides that the patient is unfit or has not been suitable prepared for the anaesthetic or surgical procedure. Such decision making can be challenging especially when additional tests are required. In these circumstances the risks of delaying surgery, which may result in worsening of the condition, must be balanced with the requirement for information that will facilitate the delivery of a safe anaesthetic and safe surgery, with a good postoperative recovery.

Peri-operative anxiety is distressing for patients and can contribute to problems during anaesthesia, unpredictable pharmacokinetic activity (47) and increased levels of post-operative anxiety and patient reported pain scores (48). Traditionally, when patients were brought into hospital the night prior to surgery, premedication with oral anxiolytics was considered standard practice (47, 49). APOAR in advance of the day of surgery avoids a pre-surgical overnight stay, thus reducing the cost of surgical intervention and may also reduce patient anxiety. More recent studies have shown that allowing patients to listen to music of their own choice can significantly reduce anxiety levels, although this effect is best achieved with patients who believe that it will be of benefit (50). The nature of the surgical intervention has implications for anxiety levels. Procedures with a diagnostic function are associated with increased anxiety because of the implications of the potential findings (51).

Post-operative nausea and vomiting (PONV) is a common distressing complication of general anaesthesia (52). Standardised risk assessment tools exist (apfel score) and assessments of the severity of PONV have also been described (53). In some cases PONV can be severe and this may recur in individual patients. Automatic prompts can be inserted into pre-operative assessment questionnaires. These can remind staff to apply special consideration to the potential causes and preventative measures. Prompts to address PONV have been shown to reduce its incidence (53). Electronic systems can be designed to automatically calculate risk scores and provide links to trust protocols and patient advice leaflets.

3.8 Pre-operative Investigations

Computerised algorithms can be used to assist decision making. There is significant national and international variability in how pre-operative investigations are requested. A National Institute of Healthcare and Clinical Excellence (NICE) Guideline CG3 (54) attempted to clarify which investigations are indicated or should be considered. However, the working group met challenges when trying to simplify the complex patient and physician-dependent process. CG3 has now been updated and superseded by NICE NG45 (55). Historically there was a tendency to over request investigations. Increased financial pressure and a drive to minimise both waste and inconvenience to patients has encouraged scrutiny of pre-operative practice (56-58). Audits have been undertaken at STH and have demonstrated that significant numbers of tests have been performed that may not have been indicated (59). One of these audits (59) indicated that more than £100,000 per year may be being spent inappropriately. This audit also confirmed the findings of a previous study, undertaken 18 years earlier, that some patients were not undergoing investigations which were indicated (60). This complex problem of trying to ensure that only justified tests are requested without impeding the care of patients was identified and discussed in a review of investigations in three American hospitals between 1979 and 1987. The authors of this American study concluded that a reduction in testing could achieve a saving in excess of

$1.3 billion per year and that a better system for avoiding unwarranted investigation is needed (61).

ASA Grade 2: adults with comorbidity from respiratory disease

Test	Age (years)			
	16 to < 40	40 to < 60	60 to < 80	≥ 80
Chest X-ray				
ECG				Yes
Full blood count	Yes	Yes	Yes	Yes
Haemostasis	No	No	No	No
Renal function			Yes	Yes
Random glucose	No	No	No	No
Urine analysis				
Blood gases				
Lung function	No			

Figure 2 *Extract from NICE guidance on pre-operative investigations CG3. The full guidance includes 38 tables similar to the one shown above. It may be necessary to cross reference up to four tables for each patient.*

In April 2016 NICE published NG45 which is an update to the CG3 guidelines (55). The revised guidelines (NG45) sought to simplify the complex CG3 tables that included age. The inclusion of age resulted in a complex system in which a patient could be allocated to one of 140 possible columns. Patients with an ASA score of greater than 2 could fall within multiple columns depending on the presence of absence of renal, respiratory or cardiac disease.

NG45 simplified the classification system for surgical severity combining Major and Major+ into a single category. NG45 also dispensed with subdividing adult patients by age. 36 complex tables were reduced to 3 simplified tables, an example of which is shown in figure 3.

CG3 took into account the presence or absence of disease processes. NG45 allows for this but also considers what is indicated for patients who are at risk of diseases such as acute kidney injury. There is a general reduction in the number of investigations that are considered mandatory, but it was emphasised that it is the clinicians responsibility to assess the patient specific risks.

Incorporating a computer algorithm that uses the patients response and CG3/CG45 to calculate a list of required investigations may reduce variability in clinical practice.

	ASA grade		
Test	**ASA 1**	**ASA 2**	**ASA 3 or ASA 4**
Full blood count	Yes	Yes	Yes
Haemostasis	Not routinely	Not routinely	Consider in people with chronic liver disease • If people taking anticoagulants need modification of their treatment regimen, make an individualised plan in line with local guidance • If clotting status needs to be tested before surgery (depending on local guidance) use point-of-care testing[1]
Kidney function	Consider in people at risk of AKI[2]	Yes	Yes
ECG	Consider for people aged over 65 if no ECG results available from past 12 months	Yes	Yes
Lung function/arterial blood gas	Not routinely	Not routinely	Consider seeking advice from a senior anaesthetist as soon as possible after assessment for people who are ASA grade 3 or 4 due to known or suspected respiratory disease

AKI, acute kidney injury.

[1] Note that currently the effects of direct oral anticoagulants (DOACs) cannot be measured by routine testing.

[2] See recommendation 1.1.8 of the NICE guideline on acute kidney injury.

Figure 3 Extract from NICE NG45 showing the investigations that are indicated for a patient undergoing Major or Complex surgery.

Attempts have been made to modify clinical practice and reduce the number of tests that are requested. A four year review of pre-operative investigations requested in an orthopaedic hospital demonstrated that although compliance with guidelines is variable, guidelines can effect change and can reduce the number of investigations requested (22 to 44% reduction) without increasing

the incidence of adverse peri-operative events (62). However this review looked at tests requested by surgeons and not by centralised pre-operative assessment centres. Clinical practice prior to the introduction of CG3's new guidelines does not match current clinical practice in the UK. The nature of the surgery could also impact on the relative need for different tests. An editorial in Anaesthesia in 2010 emphasised that undertaking a comprehensive physical examination and history remain the most efficient way of detecting morbidity (63).

There are clear guidelines on the utilisation of ECGs in the pre-operative assessment clinic (4, 54). Although it has been demonstrated that this test is unlikely to be abnormal in those who do not have any risk factors for cardiovascular disease (60) it is still routinely performed on many patients as the threshold for use is lower in non-invasive, inexpensive tests.

Cardiac complications are the most common cause of peri-operative mortality in non-cardiac surgery. Detski et al have demonstrated that valvular heart disease is an independent predictor for cardiac events in such surgery (64, 65). In a review of 2522 consecutive patients van Klei et al found cardiac murmurs during routine pre-operative physical examination in 4.9% of patients. The authors had access to echocardiography results for 79% of these patients and found that none of the patients aged less than 40 years had intra cardiac abnormalities. In those aged over 40 years the most common abnormalities were aortic and mitral valve disease. The authors concluded that auscultation of the precordium was not necessary in those aged less than 40 (66). The number of patients and case mix in the study mean that this may not be applicable to the general patient population. In addition the low number of patients may not have been sufficient to detect important but rare cases. In a more recent observational study of 100 patients aged over 65 years the authors advocated the use of 'ultrasound assisted examination' (anaesthetists TTE) for high risk patients as it provided either reassurance of non-significant abnormality or alteration in the management for patients shown to have significant defects (67).

It is still standard practice to auscultate the precordium of all patients due to undergo anaesthesia as there remains debate about to what extent we can rely solely on a comprehensive pre-anaesthetic history (68). This may be because of the low risk, and low cost associated with physical examination. Investigations, which are associated with significant cost or risk, attract greater scrutiny and their use must be justified by demonstrable benefit. An example of such a test is invasive coronary angiography.

3.9 Risk assessment scores in anaesthesia and critical care

In 2011 Pearse et al. undertook a pan European survey of outcomes following elective surgery (EuSoS) (69). EuSoS, found that the mortality following elective surgery varied significantly across Europe and that 73% of those who died were not admitted to Critical care at any point. Of those who were admitted to critical care only 71% had planned admissions. The authors concluded that these findings indicate that although adverse outcomes were predicted in some patients and there was a fundamental failure in the way that high risk patientsa were identified and critical care resources allocated.

One of the aims of my project was to be able to use the electronically captured pre-operative assessment data to calculate patient and procedure risk scores. My review of the literature identified some pre-operative risk scores that are currently used. Many of the risk assessment scores identified in my literature search focused on cardiovascular risk factors because myocardial infarction is the most common cause of peri-operative mortality following non cardiac surgery (70). Since performing my original literature search there has been a move away from using isolated physiological variables, instead utilising global functional reserve and aerobic capacity (71).

The European Society of Cardiology and American College of Cardiology have published documents on the assessment and management of cardiac risk (70, 72). These extensive and comprehensive reviews of the evidence identify relevant risk factors and explore the merits of various investigations and treatments that are aimed at reducing cardiac risk.

Diabetes mellitus is known to be an independent risk factor for peri-operative morbidity (73) and it contributes to many of the cardiac risk indices. The physical components of the SF-36 have been identified as predictors of 6 month mortality following coronary artery bypass surgery (74). The SF-36 may not be applicable to the general surgical population. Lee et al identified 6 independent risk factors for ischaemic heart disease in the peri-operative period (75). A refined form which excludes renal and diabetic factors yields better risk assessment. Lee's score is a simple additive score which is easy to use and this has contributed to its popularity. However, its end point is death in the perioperative period as a result of cardiac event. Current clinical practice means that this is a relatively rare event and more sensitive scores that relate to more common adverse events (post-operative delirium, respiratory compromise or myocardial infarction) are required.

Table 5 Lee's revised cardiac risk index

Lee's Cardiac Risk Factors
High risk surgery
History of ischaemic heart disease
History of congestive heart failure
History of cerebrovascular disease
Preoperative treatment with insulin
Preoperative serum creatinine > 177 umol/L

Smoking is a known risk factor for myocardial infarction and peri-operative respiratory complications and it also impairs bone and wound healing (76). Pre-operative assessment clinics provide an opportunity to encourage smoking cessation. Smoking cessation can be facilitated by using a structured abstinence programme and nicotine replacement therapies (77).

While measures of quality of life and health status are useful, objective biochemical markers of risk have also been sought. Such biomarkers of interest include C-reactive protein, troponins and brain natriuretic peptide. Biccard's observational study published in 2012 concluded that brain natriuretic peptide

is the only clinically applicable biochemical indicator of peri-operative complications (78).

3.9.1 ASA

The American Society of Anaesthesiologists developed a physical status scoring system that categorised patients into one of 6 groups depending on the presence of a systemic disease and its impact on functional status. This scoring system was published as a 4-point scale in 1941 (79); this was later revised and formally adopted as a 5-point scale by the ASA in 1962. The ASA score is used by anaesthetists world-wide. It has been shown to predict peri-operative mortality. The ASA score has been validated in many patient populations(80). The ASA classification system was updated in October 2014 to include new examples enabling better application of the definitions. These examples were needed to improve the uniformity with which the ASA classification system is now applied (81).

3.9.2 P-Possum

P-Possum is an acronym for Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity with the initial P denoting the Portsmouth modification to POSSUM score (82). The original POSSUM score was developed by Copeland et al in 1991 (83). It has been applied to various surgical groups with the intention of predicting peri-operative morbidity and mortality. POSSUM was intended to achieve a compromise between the subjective ASA measure and the highly complex APACHE scoring system. APACHE also requires scores obtained the eh first 24 hours of ICU admission and therefore would not be applicable without modification. POSSUM has been criticised for being too pessimistic in its prediction of peri-operative death in low risk groups, overestimating mortality. Modifications have been made to adjust for this. One of these modifications was undertaken in Portsmouth, hence the prefix P in P-POSSUM. The modification reduces predicted mortality. P-POSSUM includes both patient and surgical factors when predicting risk.

3.10 Paper questionnaires in pre-operative assessment

Anaesthetic pre-operative assessment questionnaires have been used for many decades. The earliest published papers report their use by the British Army (84). This military questionnaire was used as a simple screening tool and medical record for athletically fit young individuals who presented a low anaesthetic risk. The short questionnaire sought to obtain vital medical information that would have affected anaesthetic techniques, such as allergy or adverse reactions to medications. More detailed questionnaires are in regular use by non NHS health care providers. NHS patients who are to undergo procedures under local anaesthetic or sedation are also often given an anaesthetic pre-operative assessment questionnaire. This replaces formal face to face assessment and enables the final assessment on the day of surgery to be shortened. The questionnaire also ensures that vital investigations have been performed and checked in advance of the day of surgery.

Nurse-led anaesthetic pre-operative assessment is undertaken in most UK NHS hospitals. In order to ensure that this assessment is consistent and rigorous it is often conducted according to a strict and comprehensive question set.

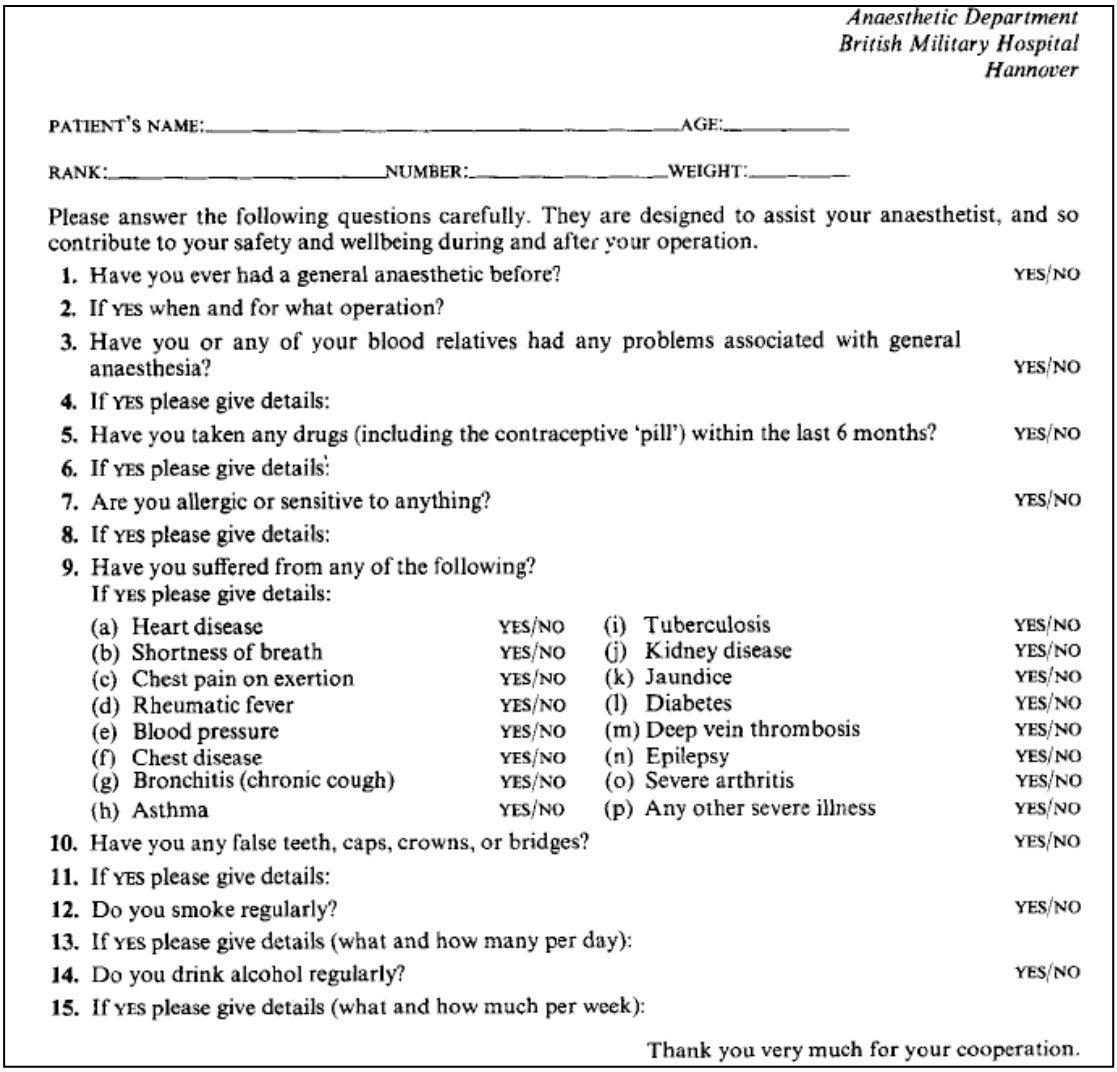
The majority of anaesthetic pre-operative assessment questionnaires are completed using paper and pen. Some centres have developed computerised systems that allow a nurse to document the patient's responses on a computer database. Decision support algorithms can then be applied to these data and be used to guide future management. There are two patient completed computerised anaesthetic pre-operative assessment questionnaires reported in the literature. These are from Canada and Holland. The Canadian questionnaire was brief and did not address specific health issues. The questionnaire from Holland has been translated into English and generates an ASA score (5, 6).

3.11 Computerised questionnaires in pre-operative assessment

VanDenKerkhof sought to compare a paper based pre-operative assessment questionnaire with three computer technologies (5). Electronically collected data was compared with a paper-based questionnaire that had been completed two weeks previously as part of their standard care. In order to simplify computerisation of the trial questionnaire the questions were modified for only yes/no responses. Patients were also prevented from providing text responses. 360 patients were recruited, 60 to each of the three computer arms. The three computer arms used different computer devices; a Personal Digital Assistant (PDA), Tablet (portable touch screen computer) or Kiosk (free standing touch-screen computer). 180 patients were assigned to the paper arm. As with previous studies the use of the PDA was associated with technical difficulties. The shortest completion time was that achieved by the kiosk users and these kiosk users also expressed the greatest degree of comfort. The mean percentage consistency across all questions was 94% with the allergy question achieving the highest level of inconsistency (23-29%). All participants awarded preference scores to their allocated response system, the users of the kiosks awarded the highest scores out of the three groups. It is interesting that 25% of all participants expressed concern over loss of paper data. 20% of participants who completed the paper questionnaire were concerned about the loss of electronic data. Only 5 to 16% of users of the computer systems reported concern over loss of electronic data. It is possible that having used the electronic system they felt re-assured about the reliability of the system. However in this study the researchers did not include history of smoking status or other health factors, which limits the clinical usefulness of the questionnaire.

Pearson et al (84) reported the use of a dichotomous (Yes/No) questionnaire which was used in British military hospitals in 1981. The questionnaire addressed previous anaesthetic issues, smoking and alcohol history, allergy and medications. 16 specific significant medical conditions were also included.

Figure 4 Pre-operative assessment questionnaire used by Pearson et al in Hannover 1981.



Anaesthetic Department
British Military Hospital
Hannover

PATIENT'S NAME:_____AGE:_____

RANK:_____NUMBER:_____WEIGHT:_____

Please answer the following questions carefully. They are designed to assist your anaesthetist, and so contribute to your safety and wellbeing during and after your operation.

1. Have you ever had a general anaesthetic before? YES/NO
2. If YES when and for what operation?
3. Have you or any of your blood relatives had any problems associated with general anaesthesia? YES/NO
4. If YES please give details:
5. Have you taken any drugs (including the contraceptive 'pill') within the last 6 months? YES/NO
6. If YES please give details:
7. Are you allergic or sensitive to anything? YES/NO
8. If YES please give details:
9. Have you suffered from any of the following?
   If YES please give details:

(a) Heart disease	YES/NO	(i) Tuberculosis	YES/NO
(b) Shortness of breath	YES/NO	(j) Kidney disease	YES/NO
(c) Chest pain on exertion	YES/NO	(k) Jaundice	YES/NO
(d) Rheumatic fever	YES/NO	(l) Diabetes	YES/NO
(e) Blood pressure	YES/NO	(m) Deep vein thrombosis	YES/NO
(f) Chest disease	YES/NO	(n) Epilepsy	YES/NO
(g) Bronchitis (chronic cough)	YES/NO	(o) Severe arthritis	YES/NO
(h) Asthma	YES/NO	(p) Any other severe illness	YES/NO

10. Have you any false teeth, caps, crowns, or bridges? YES/NO
11. If YES please give details:
12. Do you smoke regularly? YES/NO
13. If YES please give details (what and how many per day):
14. Do you drink alcohol regularly? YES/NO
15. If YES please give details (what and how much per week):

Thank you very much for your cooperation.

400 patients with a mean age of 28 yrs completed the questionnaire using pen and paper, assistance from clinic staff was available if required. In this young patient population the incidence of previous anaesthetics was surprisingly high at 73%, pre-existing medical conditions 54%, recent drug therapy 61% and allergy 17.8%. A completely blank questionnaire was received from only 1.5% of the patients. The incidence of reported pre-existing medical conditions was surprisingly high. The authors attributed this to the military background of their population causing them to be more aware of their medical conditions than the general population. The majority of reported allergies were to elastoplast and antibiotics. The authors concluded that although the questionnaire was not a substitute for full consultation and examination it did provide benefits in terms

of efficiency and record keeping. The authors also suggested that the questionnaire should be completed as soon as a decision to operate had been made allowing more time to recall patients to a dedicated clinic.

3.12 Rationale for developing a new assessment tool

The concept and value of elective pre-operative assessment has been recognised for over 90 years. In recent years a drive for improved efficiency, quality and standardisation has caused an evolution in clinical practice. Patients are increasingly managed in dedicated pre-operative assessment clinics predominantly staffed by specially trained nursing staff.

The function of pre-operative assessment remains to ensure that the patient is properly prepared to undergo anaesthesia thus reducing the risk of peri-operative complications and avoiding day-of-surgery cancellations. This is achieved through a process of information giving, thorough review of the patients' medical history and appropriate physical examination. There is a significant focus on identifying patients that are at risk of peri-operative cardiac complications. Pre-operative preparation of the patient is often associated with the ordering of numerous haematological, imaging and physiological investigations. In the UK alone nearly 3 million patients undergo anaesthesia each year. The potential for waste is significant. Much is written in the literature about the need for usable, standardised, national triage guidelines. However, there is no published evidence of these being produced or widely used.

Computerised questionnaires are widely and successfully used across a range of medical specialties, but there is no evidence of a validated patient-completed computerised comprehensive pre-operative assessment system in the published literature. Computer technology offers the opportunity for complex dynamic questionnaires to be used to drive triage systems and decision-making algorithms. These systems could enhance the efficiency of pre-operative assessment, maximising patient safety and reducing financial burden.

4 Origins of ePAQ

electronic Personal Assessment Questionnaire Pelvic Floor (ePAQ-PF) is a validated symptom assessment measure for women with pelvic floor dysfunction that allows patients to describe what might otherwise be embarrassing symptoms in a way that they perceived as more private. It was developed and validated in Sheffield and is now used as standard clinical practice in many centres. The platform used to deliver this questionnaire can be adapted for different purposes and to deliver different question sets. The platform supports the development of a dynamic questionnaire, which responds to patient-entered data permitting the delivery of a patient-specific questionnaire. This can minimise 'questionnaire fatigue' and may improve the quality of the data collected.

ePAQ uses dual server technology to permit patients access to the questionnaire from home and for clinicians to be able to access the patient identifiable data from within the N3 network. The N3 network is an encrypted, firewall protected, secure network that exists to provide increased security, specifically for use within the NHS in the UK. ePAQ-PF was cited in the 2004 NHS Innovations Annual Report and received an award for 'Best use of IT in secondary & tertiary care' HITEA awards scheme, March 2005. It was also reviewed on BBC Look North as a feature on 'Health & Family' in April, 2005. ePAQ was initially developed and validated for use in uro-gynaecology, its responsiveness and psychometric characteristics have been extensively evaluated (85-87). To date the questionnaire has only been used in patient groups with limited, speciality specific, disease groups. It has not been used in a wider population with a heterogenous mix of symptoms and co-morbidities.

4.1 ePAQ and virtual clinics

The patient acceptability of the ePAQ questionnaire in the context of a virtual clinic has been established using the QQ10 questionnaire. The QQ10 is a validated tool that is used to evaluate the value and burden that a questionnaire places on patients. QQ10 data has demonstrated that the ePAQ questionnaire has a low burden and high value (88).

ePAQ has evolved from a women's health outcome measure (ePAQ-PF) into a clinical tool, which is completed via the Internet in advance of clinic appointments.

5 Aims and Methodology

The aims of my study were:

1. To develop a patient completed pre-operative assessment questionnaire
2. To create an electronic, patient-completed, version of this questionnaire
3. To ascertain the validity and reliability of the electronic questionnaire
4. To establish whether it was feasible to use the electronic questionnaire in routine clinical practice.

This prospective study at Sheffield Teaching Hospitals NHS Foundation Trust (STH) was completed in three phases over a three-year period between May 2009 and January 2012. After initial item generation and creation of a computerised pre-operative assessment questionnaire, this questionnaire was given the name: electronic Personal Assessment Questionnaire Pre-Operative (ePAQ-PO). A two phase study followed to assess validity and acceptability of ePAQ-PO. Having established the validity of ePAQ-PO, it was deployed in a live clinical context and steps were made to assess impact and confirm its safety.

Sheffield Hospitals Charitable Trust provided funding for this work. The South Yorkshire Regional Ethics Committee granted ethical approval for the study REC 09/H1308/127.

The specific methods for each section are described in the following chapters.

5.1 Ethics, Service Evaluation and Audit permissions

This project incorporates a number of different components that were completed at separate time points. During the development process appropriate permissions were sought for each of these component parts.

Original ethical approval for phases 2 and 3 of the development and validation process was obtained from the South Yorkshire Regional Ethics Committee (reference 09/H1308/127)

Sheffield Teaching Hospitals Audit permission was sought for the evaluation of pre-operative investigations. (reference 4381)

Service evaluation permission for the time and motion study at Sheffield Teaching Hospitals was granted (reference no. 4570)

Permission was also obtained for the assessment of patient value and burden (reference 4819)

Service evaluation permission was obtained for examining the time needed for nurses to complete a face-to-face pre-operative assessment.

Appropriate permission will also be gained for all future work that is reported in this thesis. This will be reported accordingly.

5.2 Description of anaesthetic pre-op assessment service at STH

Sheffield Teaching Hospitals NHS Foundation Trust (STH) has a centralised service that handles the majority of anaesthetic pre-operative assessments in two dedicated outpatient facilities. The clinic is staffed largely by nurse practitioners who have completed the STH/Sheffield Hallam University degree level course in pre-operative anaesthetic assessment. A consultant anaesthetist is present during the morning sessions and there is always a consultant available for advice about more complex cases. At present, all patients are brought to the clinic for face-to-face assessments. On arrival, patients confirm demographic details with reception staff; they are then provided with information leaflets and taken through to the dedicated clinic. A health care assistant measures the patient's height and weight before obtaining a mid-stream urine sample. Patients are then seen by either a staff nurse or nurse practitioner with whom they complete a structured, questionnaire based, interview. The physical examination is completed by a nurse practitioner. After assessment, relevant blood samples are taken and the patient may be sent for further investigations or assessed by a consultant anaesthetist. Patients with outstanding or abnormal investigations may then be contacted by phone or brought back to the clinic if further assessment is needed. Specific risks and patient concerns are discussed during the interview and examination.

There is considerable variability in the time taken to complete the pre-operative assessment process, with many patients spending more than three hours at the hospital. A significant proportion of this time is spent waiting between each stage in the assessment process.

5.3 Recruitment, Inclusion and Exclusion Criteria

Patients were recruited, in accordance with the approved protocol, from surgical outpatients at the Royal Hallamshire Hospital (RHH), Sheffield, England.

The questionnaire was to be developed for a largely English speaking population. In this stage of the study the questionnaire had been developed in the English language only. It was anticipated that once validated in English, it would be possible to validate translated versions of the questionnaire in the future.

Inclusion criteria: patients were to be aged 18 years or older at the time of recruitment and were able to read and understand English.

Exclusion criteria were visual impairment, age less than 18 years and non-English speaking.

Patients due to undergo urology, gynaecology, orthopaedics or neurosurgery procedures were approached by a research nurse in the surgical outpatient clinic. They were provided with written information about the study. All participants provided written informed consent in accordance with the research protocol.

6 Phase 1: Item Generation and Face Validity

6.1 Method

Face validity is the simplest form of validity where an expert panel gives their subjective assessment of the extent to which a tool measures what it intends to measure. Criterion validity is how well the outcome of one question matches the outcome of another question that is designed to measure the same item. Construct validity is the extent to which a test measures what it is supposed to measure.

An expert panel was formed comprising 3 consultant anaesthetists, a consultant surgeon, pre-operative assessment leads, a psychologist and an Information Technology (IT) specialist. The questions were intended to cover the scope of the current pre-operative assessment including the following domains; cardiac, respiratory, endocrine, pharmacological, haematological, social, gastrointestinal, anaesthetic, airway and miscellaneous items.

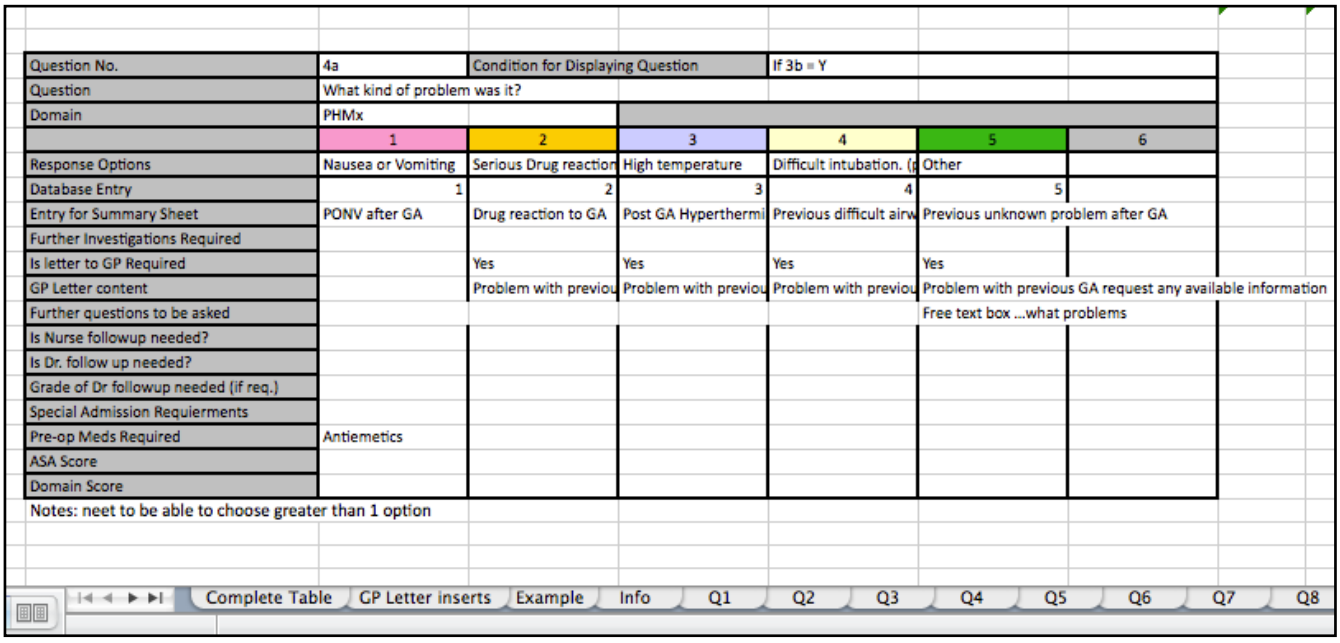
The expert panel members independently generated lists of questions. These were merged, repeated items were removed, and a Microsoft Excel workbook was generated. This workbook was circulated to all the panel members. Panel members had access to the paper record that was already being used in the pre-assessment clinics. Each panel member was given a group of questions for which they were assigned possible response options and ASA scores. They were also asked to indicate what action would be triggered by each of the possible patient responses. An extract from this work book is shown in Figure 4.

6.2 Results

Once all the questions had been populated the expert panel met to discuss the responses to each question. Any question that did not trigger a clinical action was removed, questions that were thought to be necessary by at least two panel members were retained. The wording of some of the questions was also changed. The panel had intended to assign ASA scores to the response options, but after extensive discussion it was decided to leave this step until patient feedback had been received.

The final questionnaire contained 120 items, which could be divided into 5 domains. The original protocol had anticipated that 64 items would be generated.

Figure 5 Extract from microsoft Excel workbook which was used to compile and assess face validity of ePAQ-PO version 1 questions



Question No.	4a	Condition for Displaying Question		If 3b = Y		
Question	What kind of problem was it?					
Domain	PHMx					
	1	2	3	4	5	6
Response Options	Nausea or Vomiting	Serious Drug reaction	High temperature	Difficult intubation. (p	Other	
Database Entry	1	2	3	4	5	
Entry for Summary Sheet	PONV after GA	Drug reaction to GA	Post GA Hyperthermi	Previous difficult airw	Previous unknown problem after GA	
Further Investigations Required						
Is letter to GP Required		Yes	Yes	Yes	Yes	
GP Letter content		Problem with previou	Problem with previou	Problem with previou	Problem with previous GA request any available information	
Further questions to be asked					Free text box ...what problems	
Is Nurse followup needed?						
Is Dr. follow up needed?						
Grade of Dr followup needed (if req.)						
Special Admission Requierments						
Pre-op Meds Required	Antiemetics					
ASA Score						
Domain Score						
Notes: neet to be able to choose greater than 1 option						

Complete Table | GP Letter inserts | Example | Info | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8

7 Phase 2: Initial patient experience and item reduction

7.1 Method

Content validity, face validity, feasibility & acceptability of ePAQ-PO was assessed in a sample of 30 pre-operative patients. These patients were specifically asked to comment on:

1. Over-all impression of the questionnaire
2. Ease of use
3. Content
4. Language
5. Relevance
6. Missing items or areas not covered by ePAQ-PO

Following expert panel review of the findings, changes to the format and content of the questionnaire were made.

'Content validity' refers to how well a questionnaire reflects the scope of the area being assessed. Whilst a basic structure and content for the first prototype of ePAQ-PO was created, this was based on literature review and clinician opinion. To evaluate the content and face validity of ePAQ-PO and its acceptability to patients, a qualitative study design was used, involving a total of 30 patients in 6 diverse clinical settings.

Sample size

A heterogenous group of elective surgical patients were recruited. The sample size of 30 was consistent with previous studies of face validity (5).

7.2 Results

30 patients were recruited from a variety of surgical specialities at the Royal Hallamshire Hospital, Sheffield. A research nurse attended the surgical outpatients clinic. Clinic staff identified patients who were going to be listed for surgery. These patients were approached by the research nurse and given written information in accordance with the original ethics protocol.

All patients received a paper version of ePAQ-PO and were asked to make specific comments on the questionnaire before attending a one-to-one semi-structured interview with the research nurse. This 20 - 30 minute semi-structured interview included completion of the electronic questionnaire ePAQ-POv1 (version 1) and an interview exploring their views about the questionnaire.

The interview was recorded and transcribed. The research nurse also noted the level of assistance needed. The interviews were analysed and consistent themes were identified. Patients completed the QQ-10 questionnaire relating to their views on ePAQ-PO V1.

7.3 Results

30 patients were recruited to Phase 2. 15 were ASA 1, 11 were ASA 2 and 4 were ASA 3. The age range was 25 to 74 years with a mean of 51.7 yrs (SD 12.9).

Table 6 Phase 2 Research patients response to the 6 positive items in the QQ10 which asked them about the electronic ePAQ-PO questionnaire n=30

	The questionnaire helped me to communicate about my condition	**The questionnaire was relevant to my condition**	**The questionnaire was easy to complete**	**The questionnaire included all the aspects of my condition that I am concerned about**	**I enjoyed filling in the questionnaire**	**I would be happy to complete the questionnaire again in the future as part of my routine care**
Strongly disagree	4	3	0	2	0	0
Mostly disagree	1	2	0	1	0	0
Neither agree nor disagree	7	8	0	9	6	0
Mostly agree	11	9	11	11	14	8
Strongly agree	7	8	19	7	10	22
Total	**30**	**30**	**30**	**30**	**30**	**30**

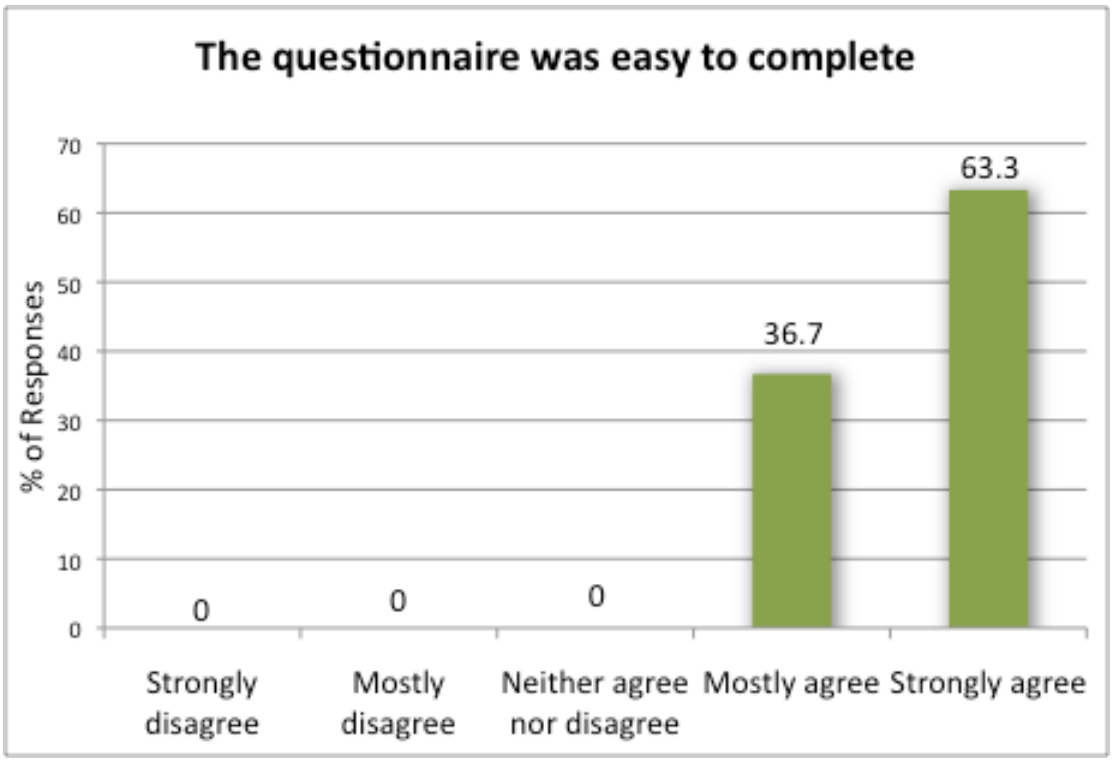
The QQ10 also asks patients to respond to four negative statements about the questionnaire.

Table 7 Phase 2 research patients response to the 4 negative items in QQ10 which asked them about the electronic ePAQ-PO questionnaire n=30

	The questionnaire was too long	**The questionnaire was too embarrassing**	**The questionnaire was too complicated**	**The questionnaire upset me**
Strongly agree	0	0	0	0
Mostly agree	0	0	0	0
Neither agree nor disagree	6	1	1	0
Mostly disagree	14	9	11	2
Strongly disagree	10	20	18	28
Total	**30**	**30**	**30**	**30**

The majority of patients agreed with positive statements, representing value, and disagreed with negative statements, representing burden. Therefore the QQ 10 data reflects a high value and low burden for ePAQ-PO V1. These results reassured the expert panel that it was acceptable to continue with the development process.

Figure 6 Bar chart showing how phase 2 research patients responded to the statement "The questionnaire was easy to complete"



This chart indicated that all phase 2 patients found that the questionnaire was easy to complete.

The expert panel reviewed the transcriptions and written responses. The panel made recommendations that included altering questions and introducing new additional items in order to generate ePAQ-POv2 (version 2). The low level of burden gave the panel the confidence to add items that it was thought had been wrongly omitted.

8 Phase 3: Establishing the psychometric properties of ePAQ-PO

8.1 Method

The validity, reliability and feasibility of use of ePAQ-PO was assessed in a larger group of 300 patients in the clinical settings for which it was intended. This included patients undergoing anaesthesia and surgery for a diverse range of conditions. This third stage of the study sought to establish the domain structure and scoring system (factor analysis), construct and criterion validity, internal reliability and test-retest reliability.

8.1.1 Sample size

The instrument was intended to comprise a total of 64 items in 5 dimensions. The dimensions were 'personal, anaesthetic, cardio-respiratory, general and haematology'. A ratio of 3:1 respondents to variables is considered adequate for factor analysis (32). At the time of writing the protocol this study therefore aimed to recruit 300 patients.

However, the instrument used in this stage of the study contained more than the predicted 64 items and the questionnaire structure allowed patients more than three responses to some questions. The sample size in this study was therefore insufficient.

8.1.2 Recruitment

Potential recruits were to be identified by the attending clinician in 5 pre-op clinics at Sheffield Teaching Hospitals NHS Foundation Trust:

i) Orthopaedics
ii) General Surgery
iii) Gynaecology
iv) Urology
v) Neurosurgery
vi) Day Case Unit

All potential recruits were provided with an information pack which included: a letter of invitation, an information leaflet and a consent form.
However, recruitment was slow and therefore permission to extend the research deadline and alter the recruitment method was obtained. The modification to the protocol allowed the researchers to post printed information to patients and invite them to contact the research team via a pre-paid envelope and response slip. These patients were then contacted and given the opportunity to discuss the project with a research nurse. Patients then attended the Clinical Research Facility at RHH where they gave written consent and completed the computerised version of ePAQ-PO, with an electronic version of QQ10. Patients also completed a paper version of the SF12 questionnaire. The research nurse used this visit to obtain further information from the paper notes and copy the face-to-face pre-operative assessment record.

150 patients were invited to complete the computerised version of ePAQ-PO for a second time. This second completion took place either from home via the internet or when they attended for surgery.

All participants were asked to complete ePAQ-PO (version 2), in a private room, using a touch-screen computer terminal and all patients were asked to also complete the QQ-10.

Criterion validity (the extent to which a measure correlates with an existing measure or standard) was assessed by asking all participants to complete 2 other standardised tools in this area: the SF-12 and the American Society of Anaesthesiologists (ASA) grading system.

In order to assess the test-retest reliability of ePAQ-PO, a sample of patients were invited to repeat the questionnaire at least 2 weeks after the first completion.

8.1.3 Hypothesis

To evaluate the construct validity of ePAQ-PO it was hypothesized that:

i) The grade measured by the ASA system would correlate positively with the corresponding scores of the ePAQ-PO

ii) A higher incidence of predicted anaesthetic issues would be observed in older patients

iii) Severity of HRQoL of the SF-12 would correlate positively with those of ePAQ-PO

8.1.4 Data Analysis

Analyses were performed with SPSS 20 and 21.

Qualitative Data

Data analysis was to be conducted using NVivo (a software programme specifically designed to analyse qualitative data). All interviews were tape-recorded, transcribed and the data was to be entered into NVivo. However the data was first analysed using a thematic approach (89) Thematic analysis is a generic approach to data analysis, widely used in qualitative research which enables data sources to be analysed in terms of principal concepts or themes. The consistent themes were clearly identified in this initial thematic analysis of the patient feedback and therefore NVivo was not used.

Acceptability of ePAQ-PO

This was assessed by measuring the amount of missing data from ePAQ-PO and by assessing the scores for value and burden as measured by the QQ-10.

Feasibility of ePAQ-PO

The feasibility of ePAQ-PO use within a clinical setting was evaluated by measuring the time taken to complete the questionnaire in clinic, degree of supervision and/or support required as well as the proportion of patients who were unwilling or unable to complete the questionnaire.

Domain Structure of ePAQ-PO

Traditional questionnaire design starts with a large questionnaire which is then refined. The process or refinement removes redundant, unreliable or repetitious questions. Questions which examine similar items are considered to be in the same 'domain'. To generate the questionnaire dimensions from the initial pool of items a method of test construction known as factor analysis was to be conducted. Factor analysis is a statistical procedure which enables the underlying dimensions of an instrument to be determined. It simplifies complicated sets of data into factors using methods such as principal component analysis, which is a technique used to reduce a large number of items on a questionnaire into a smaller number of dimensions. It does this by statistically determining which items are related to others. Each factor that is produced is therefore an indication of the relationships between a set of variables (90). We intended to undertake factor analysis by using varimax rotation, the most commonly used method, which attempts to maximise the amount of variance explained. However, financial constraints and a local concerns over questionnaire length meant that a branching structure was built into the electronic questionnaire from the outset. This meant that questions were divided into branches and stems, not all patient saw all questions. The result of this was that factor analysis could not be performed.

Internal Reliability Consistency

Cronbach's alpha reliability coefficient is the measure which is most frequently used to establish the internal consistency and reliability of a questionnaire (i.e. the extent to which items within a scale are associated with each other, the homogeneity of the items and whether it measures the intended target) (91). Cronbach's alpha provides a numerical value to describe the variance between measures within a score and variance of the total score. As variance decreases the alpha score will increase coming closer to a score of 1. Cronbach's alpha was calculated in this study. An alpha value of 0.7 or more was accepted the threshold for reliability, this is consistent with outer validation studies (92).

ASA score analysis

An assessment of reliability was made by comparing the ASA scores assigned by ePAQ PO with the ASA scores assigned by experts in pre-operative assessment. As the ASA score is recognised to be highly subjective the opinions of 2 experts were obtained. The scores were compared using intra-class correlation coefficient. ASA scores were correlated with age and health status. Sensitivity and specificity were calculated and receiver-operating characteristics and Cronbach's alpha coefficient was calculated and used to assess the reliability of the calculated ASA scores.

8.2 Results

300 patients were recruited, over a period of 18 months, from the RHH in Sheffield. Recruitment was initially planned to last 1 year but difficulties in accessing the clinic patients meant that an extension and modification to the protocol was required. The modification allowed the research team to contact potential recruits by post. The mean age was 54 yr (SD¼15). 11.6% were aged over 70 years. Forty-five per cent were ASA I, 43.7% were ASA II, and 11.3% were ASA III. Sixty-five per cent were female and 35% male.

8.2.1 Factor Analysis

When developing and validating a new symptom assessment questionnaire it is common practice to develop a comprehensive set of possible items and then reduce and refine these by removing redundant items as identified by factor analysis. At the point of protocol writing and study design it was anticipated that the questionnaire would be subjected to factor analysis.

The ePAQ-PO data set was not subjected to factor analysis because financial and logistical constraint meant that the questionnaire was developed and deployed, from the outset, with a branched, dynamic structure. As a result not all patients saw all the questions and it would be incorrect to attempt to draw correlations between questions which were unanswered. Instead, the domain structure was determined by the expert panel and an algorithm was constructed that allowed patients to skip questions automatically. This pragmatic approach was necessary because financial constraints required the project to move rapidly to a stage where clinical deployment was possible. The success of this project required progressive evaluation and adaptation in a ‘live’ clinical environment. Hospital managers demanded reassurance that clinic staff and patients would not be inconvenienced by an unnecessarily long questionnaire. Reassurance was provided by obtaining realistic acceptability and burden feedback early in the process. These data enabled the hospital management teams to allow further rollout. Value and burden data was also needed for the investigators to justify further work. ePAQ-PO is different from other disease

specific symptom assessment questionnaires in that there are many items that are not relevant for the majority of the patients completing the questionnaire and the question themes fall into logical system and symptom based domains. Therefore adopting a pragmatic approach at the expense of statistical and academic rigor is unlikely to have altered the outcome of the questionnaire design.

8.2.2 Patient reported value and burden (QQ10)

Phase 3 data was used to make an assessment of value and burden. In phase 3 patients were asked to complete the computerised version of ePAQ-PO V2. These patients then completed a paper version of the QQ10 questionnaire to evaluate the acceptability or ePAQ-PO to patients. The QQ-10 is a 10-item questionnaire that explores patient views on the use of the electronic questionnaire in the context of their clinical episode. Each item includes a statement followed by a five-point response scale from ‘strongly disagree’ to ‘strongly agree’. The value and burden scales from QQ-10 were computed.

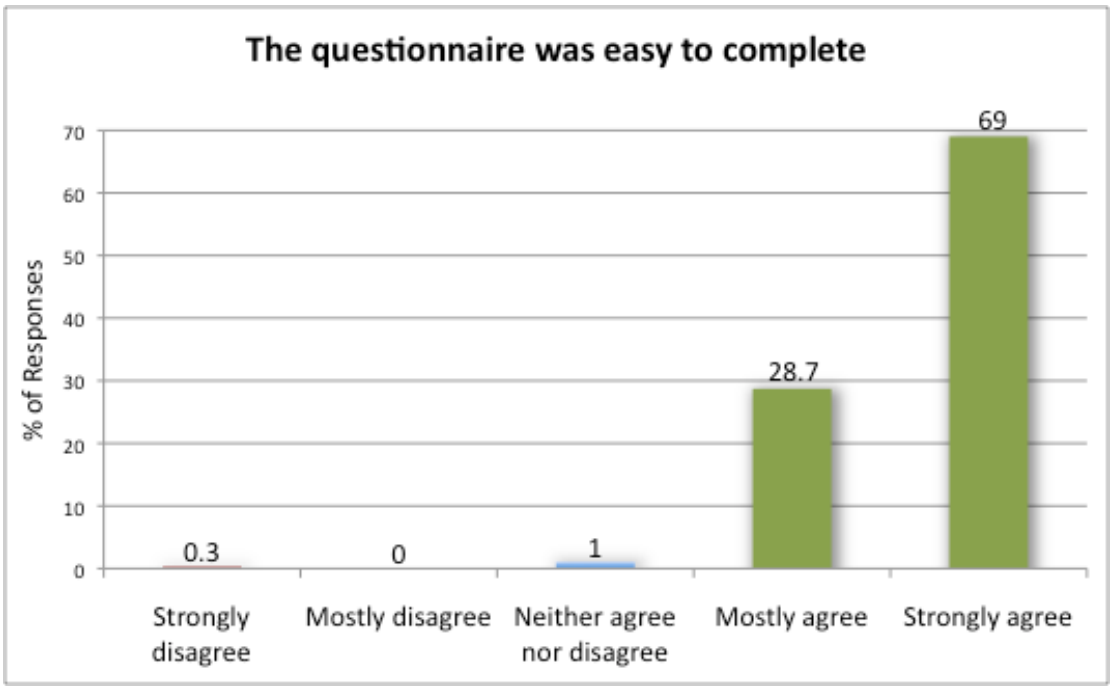
8.2.2.1 QQ 10 in a research population

Of the 300 patients who were recruited to Phase 2 only 293 patients completed the whole QQ10 paper questionnaire. The QQ10 asks patients to respond to six positive statements about the questionnaire.

Table 8 Phase 3 Research patients response to the 6 positive items in the QQ10

	The questionnaire helped me to communicate about my condition	**The questionnaire was relevant to my condition**	**The questionnaire was easy to complete**	**The questionnaire included all the aspects of my condition that I am concerned about**	**I enjoyed filling in the questionnaire**	**I would be happy to complete the questionnaire again in the future as part of my routine care**
Strongly disagree	3	3	1	7	0	1
Mostly disagree	11	16	0	19	5	0
Neither agree nor disagree	54	88	3	76	46	4
Mostly agree	133	126	87	106	124	56
Strongly agree	96	64	207	88	122	236
Total	**297**	**297**	**297**	**297**	**297**	**297**

Figure 7 Bar chart showing how phase 2 research patients responded to the statement "The questionnaire was easy to complete"



In phase 2 no patient indicated that the questionnaire was not easy to complete. In phase 3 the results were a little different, 1 patient indicated that the questionnaire was not easy to complete. This patient did not complete the second side of the paper QQ10 questionnaire so their free text comments were not available for analysis.

The QQ10 also asks patients to respond to four negative statements about the questionnaire.

Table 9 Phase 3 research patients' response to the 4 negative items in QQ10

	The questionnaire was too long	**The questionnaire was too embarrassing**	**The questionnaire was too complicated**	**The questionnaire upset me**
Strongly agree	5	0	0	0
Mostly agree	5	0	2	0
Neither agree nor disagree	46	8	11	5
Mostly dis agree	78	53	73	29
Strongly dis agree	159	232	207	259
Total	**293**	**293**	**293**	**293**

The majority of patients 'mostly' or 'strongly' agreed with statements relating to improved communication (77%) and ease of use (98.7%). 82.9% enjoyed completing the questionnaire and 98.4% said that they would be happy to complete it again in the future as part of their standard care. No patient found it embarrassing or upsetting only 0.7% of the participants found it too complicated but 3.4% felt that the questionnaire was too long. A Value score of greater than 80 was used as the acceptable threshold and a burden score of less than 20 was used as the burden threshold. The mean value and burden score for the cohort were 81 and 9, respectively (SD 13.2 and 11.5). There was a trend towards increased value scores for patients with higher ASA scores. These data suggest high patient acceptability and value attributable to ePAQ-PO. The

burden of the questionnaire is low. The web-based questionnaire is likely to be accepted and used by the majority of patients undergoing elective preoperative assessment.

The population included in this study is relatively young when compared with the general surgical population. They were selected by virtue of their willingness to participate in the research project. This was considered a major limitation of the study and it was deemed necessary to evaluate the system in a live clinical setting with a more representative patient population.

8.2.2.2 QQ10 in a real patient population

The QQ10 analysis performed in phase 2 of the study has been repeated within a live clinical setting. On the basis of the work already conducted the Pre-operative Assessment Management Team at STH decided to introduce ePAQ-PO into the standard clinical care of non-oncology gynaecology patients. All patients that attended the gynaecology outpatients clinic and were subsequently referred for anaesthetic pre-operative assessment were given the opportunity to complete ePAQ-PO on-line prior to their anaesthetic pre-operative assessment. ePAQ-PO incorporates the QQ10 questionnaire. This is included as standard as a way in which health care providers can continually assess the value and burden of ePAQ-PO on their clients.

Methods

Recruitment letters containing vouchers codes were handed to patients when they left the gynaecology outpatient clinic, it was not compulsory for the patients to complete the questionnaire and no reminders were given to the patient prior to attending clinic.

Permission for a service evaluation was granted by STH Clinical Effectiveness Department.

Data was collected retrospectively by interrogating the STH ePAQ database. As a result of the way in which data is stored on the database it is possible to duplicate patient records. Duplicated records had to be removed prior to being anonymised and analysed. Data was analysed in SPSS 21 and Microsoft Excel.

2029 ePAQ voucher codes were issued between September 2013 and September 2014. Only 38.6% of vouchers were completed prior to the patient attending the pre-operative assessment clinic. This low level of uptake is likely to have occurred because of a number of factors; poor patient education, poor understanding of clinic staff, multiple leaflets given at once and optional compliance with completion.

Table 10 Age of responders and non-responders to ePAQ-PO when used by non-oncology gynaecology patients at STH between Sept 2013 and Sept 2014

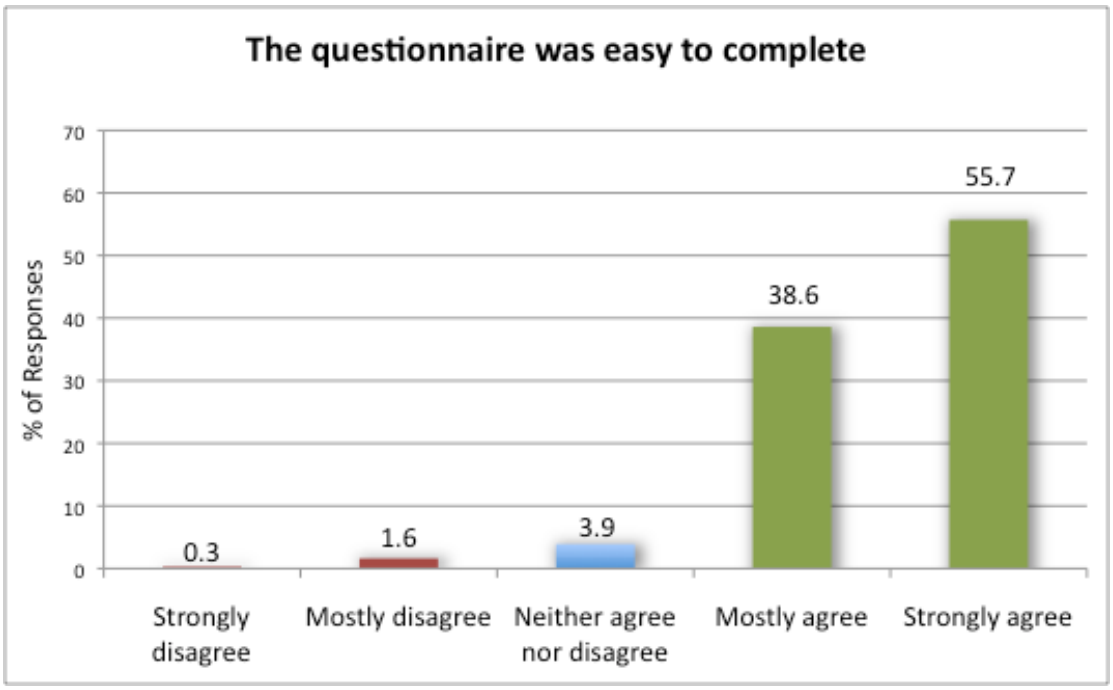
	Responders ePAQ-PO	Non responders ePAQ-PO
N	783	1246
Mean Age yrs	44.2	42.6
SD (yrs.)	14	14.5
Min Age	15	13
Max Age	89	85

The QQ10 asks patients to respond to six positive statements about the questionnaire.

Table 11 Non-oncology gynaecology patient responses to the QQ10 questionnaire Questions 1 to 6

	The questionnaire helped me to communicate about my condition	**The questionnaire was relevant to my condition**	**The questionnaire was easy to complete**	**The questionnaire included all the aspects of my condition that I am concerned about**	**I enjoyed filling in the questionnaire**	**I would be happy to complete the questionnaire again in the future as part of my routine care**
Strongly disagree	7	10	2	22	21	0
Mostly disagree	37	66	12	74	52	36
Neither agree nor disagree	235	297	30	290	412	120
Mostly agree	303	266	296	256	192	358
Strongly agree	173	116	427	125	90	253
Total	**755**	**755**	**767**	**767**	**767**	**767**

Figure 8 Bar chart showing how standard clinic patients respond to the statement "The questionnaire was easy to complete"



These data indicate that standard clinic patients were less likely to respond favourably to the questionnaire. However, the majority of patients who completed the questionnaire did still find it easy to complete. The measure 'easy to complete' has been reported in graphical format as ease of completion was the greatest concern raised by clinicians and managers. However, willingness to complete again is probably a more relevant measure. This is because even if it is embarrassing or complex to complete, if patients feel that it is relevant to their care then they will be willing to comply with the request to complete the questionnaire.

During the period analysed 2,029 vouchers were issued, only 38.6% of these were completed. The QQ10 data is provided by the patients who completed the questionnaire. It is possible that the other patients did not complete the questionnaire because they found it too difficult or offensive. More work is needed to clarify this potential source of bias.

The QQ10 also asks patients to respond to four negative statements about the questionnaire.

Table 12 Non-oncology gynaecology patient responses to QQ10 questionnaire questions 7 to 10

	The questionnaire was too long	**The questionnaire was too embarrassing**	**The questionnaire was too complicated**	**The questionnaire upset me**
Strongly agree	48	3	6	3
Mostly agree	111	11	18	3
Neither agree nor disagree	336	196	155	96
Mostly disagree	162	196	241	149
Strongly disagree	112	363	352	521
Total	**769**	**769**	**772**	**767**

The QQ10 covers 10 key domains. The following charts summarise the patient responses to the three questions considered most relevant to patient experience.

8.2.2.3 Discussion

These results indicate that ePAQ-PO version 2 has a high level of value to patients and a low burden in a real patient population. It is therefore likely that ePAQ-PO would be acceptable to patients if it were to be adopted into standard clinical practice. However, a large number of vouchers were issued to real patients and not used. There are a large number of possible reasons for this, and it is possible that our feedback data is biased towards patients that were willing and able to complete the questionnaire. It is therefore important that further work is undertaken to establish the reasons for non-completion and whether the system is acceptable to all patients.

8.2.3 Internal Consistency

A number of questions within the questionnaire address the same health issue. Analysis of the data will be performed to achieve a measure of internal consistency.

8.2.4 Stability - Test Retest

8.2.4.1 Method

The original protocol stated that 150 patients, from phase 3, would be required to complete the questionnaire twice to enable test retest analysis. The difficulties in recruitment and pressures on data collection meant that patients were invited to undertake their second completion from home via the internet instead of completing it in the clinic. It was not possible to guarantee that patients were going to complete the questionnaire so more patients than originally intended, were invited to do this.

Single response multiple choice items were used for test-retest analysis. The data was entered into an Excel spreadsheet and responses were compared using an Excel formula. The branched structure of the questionnaire meant that some patients might not have been directed to some questions. The number of discrepancies for each individual question was counted and expressed as a percentage of the number of times that that question was answered. The analysis was repeated in SPSS 21, the data was imported, cleaned and coded. Pivot tables were generated for each question, errors were identified and the questions were ranked according to their error rate.

8.3.1.1 **Results**

A subset of 154 of the 300 Phase 3 patients completed the computerised version of ePAQ-PO V2 twice, 85% of patients had completed the questionnaire for the second time from home. This allowed an assessment of test-retest reliability. An error was deemed to have occurred if the patient changed their response between the first and second completions.

Table 13 The demographic structure of the test-retest patient group compared with the entire phase 3 patient group

	All subjects	**Test-retest subjects**
n	300	154
Age in years (SD)	53.8 (14.2)	54.1 (13.8)
Male/Female (%)	36/64	28/72
ASA 1 %	46	47
ASA 2 %	44	46
ASA 3 %	10	7

A total of 71 questions and 9,113 patient responses were included in the analysis. Overall there were 294 errors identified 75% of the errors arose from 26% of the questions. This indicates that some questions were more prone to error than others, more detailed analysis of this was therefore required.

Table 14 Test-retest error rate for questions in ePAQ-PO Version 2 with a 0% error rate in Phase 3

Question Text	% error	N
Are you male or female? please tell us.	0.0	154
Are you pregnant?	0.0	106
Do you have a heart pacemaker or similar device?	0.0	154
Do you have asthma?	0.0	154
Do you have diabetes?	0.0	154
Do you have home oxygen?	0.0	3
Do you take HRT (Hormone Replacement Therapy)?	0.0	111
Do you take methadone?	0.0	154
Do you take warfarin?	0.0	154
Do you take, the heart drug, digoxin?	0.0	154
Has anyone in your family had problems with anaesthetics?	0.0	10
Have you ever had an operation?	0.0	154
Have you ever had any operations on your heart?	0.0	154
Have you ever had treatment for heart failure?	0.0	154
Have you or a member of your family ever been diagnosed as suffering from Creutzfeld-Jakob disease (CJD)?	0.0	154
Have you received growth hormone or gonadotropin treatment?	0.0	153
To your knowledge, do you have HIV?	0.0	154
When was your last heart attack?	0.0	5
Would you be willing to have a blood transfusion if it were necessary?	0.0	153
Are you sure that you would not want a blood transfusion, even if it was potentially lifesaving?	0.0	2
Do you take the contraceptive pill?	0.0	106
Have you ever had laser treatment to your eyes?	0.0	13

Table 15 Test-retest error rate for questions in ePAQ-PO Version 2 with an error rate less than 1% in Phase 3 data

Question Text	% error	N
Do you have access to a telephone?	0.6	154
Do you have chronic bronchitis or emphysema?	0.6	154
Do you have epilepsy or take medication to prevent seizures?	0.6	154
Do you smoke?	0.6	154
Do you take any blood-thinning drugs other than warfarin? (E.g. aspirin or clopidogrel)	0.6	154
Have you ever had a heart attack?	0.6	154
Have you ever had a stroke or a TIA? (a 'mini-stroke')	0.6	154
Have you ever had any problems with your thyroid?	0.6	154
Have you ever injected drugs not prescribed by your doctor?	0.6	154
If you lie flat do you get short of breath?	0.7	153
Do you have an on-going psychiatric/mental health disorder e.g. schizophrenia, bipolar disorder, severe depression or anxiety?	0.7	150
Have you ever been a smoker?	0.7	144

Table 16 Test-retest error rate for questions in ePAQ-PO Version 2 with an error rate between 1% and 4.9% in phase 3

Question Text	% error	N
Do you have a responsible adult to accompany you home and stay with you for 24 hours after your operation?	1.3	154
Have you ever been told that you have a heart murmur?	1.3	154
Have you ever had TB?	1.4	147
Would you be willing for us to contact your GP to confirm what these medications are?	1.7	119
When did you stop?	1.7	58
Do you have anaemia? (Low blood count or low iron in the blood)	1.9	154
Do you take any medication for your blood pressure?	2.1	47
Do you ever suffer from black-outs / fainting?	2.6	154
Do you have any problems opening your mouth wide?	2.6	154
Do you take any diuretics (water tablets)?	2.6	154
Has a doctor changed your blood pressure treatment within the last 6 months?	3.2	31
Do you regularly get sick when travelling in a car or bus? This can indicate how likely you are to feel sick after your operation.	3.2	154
Have you ever had liver disease? E.g. jaundice, hepatitis, cirrhosis, fatty liver	3.2	154
Do you use inhalers (puffers)?	3.8	26
Have you ever been found to have MRSA?	4.0	149
Do you have, or have you ever had, high blood pressure?	4.5	154
Do you or anyone in your family suffer from any of the following blood problems?	4.5	154
Have you ever suffered from excessive bleeding that has been difficult to stop?	4.5	154

Table 17 Test-retest error rate for questions in ePAQ-PO Version 2 with an error rate greater than 5%

Question Text	% error	N
Do you take any prescribed medication?	5.2	154
Have you ever experienced angina (chest pain from your heart)? If you are unsure then please answer: don't know	5.2	154
Thinking about the last 4 weeks, How much alcohol do you drink in one week? (1 unit = 1 small glass of wine, half a pint of beer or a measure of spirit)	5.2	154
Have you ever had a kidney problem?	5.8	154
Do you have a hiatus hernia?	6.5	154
Do you have any allergies? E.g. medicines, food, dressings.	6.5	154
Do you suffer from abnormal heart beats or are you ever aware of your own heartbeat? (palpitations)	6.5	154
Have you taken oral steroids? (e.g. prednisolone)	7.1	154
Do you take any medication for angina (chest pain or tightness)	7.7	13
Do you take drugs for reflux or heartburn (indigestion)? (e.g. omeprazole, ranitidine, lansoprazole, gaviscon.)	7.8	154
In the past, has anyone had any problems taking blood from you?	7.8	154
Do you have any neck stiffness or pain?	8.4	154
It is sometimes necessary to give patients a blood transfusion during their operation. Have you ever had a blood transfusion?	8.4	154
When did you last have chest pain?	9.1	11
Did you have any problems with the Anaesthetic?	9.2	141
Do you suffer with heartburn?	11.7	154
How much do these palpitations interfere with your daily life?	16.7	24
Are you able to take Non Steroidal Anti Inflammatory Drugs (NSAIDSs) e.g. Aspirin, Nurofen, Ibuprofen, Volterol?	17.5	154
Are you a heavy snorer?	19.5	154

The 10 questions that had the highest error rate were to reviewed by the patient public participation group and the expert panel. These questions were then re-written for ePAQ-PO version 3.

8.3.1.2 **Kappa and Proportion of Agreement**

Proportion of agreement does not take into account the amount of agreement that can occur as a result of chance. Therefore, some authors advocate the use of Cohen's Kappa for assessing agreement between observations of a binary variable.

Of the 120 questions in ePAQ-PO V2.0, there were 65 that required patients to select only one response from a range of possible answers. Forty questions

were binary (e.g. yes/ no) and 25 offered a choice of three or more response options (e.g. yes/no/don't know). Binary/nominal items were analysed using Cohen's Kappa (k) values (93). Proportion of Agreement is the proportion of correct responses; a value of less than 0.9 was used as the threshold for item review. k is a measure of agreement between two raters (people allocating a score) that is adjusted for agreement occurring by chance. A k value of 1 indicates complete agreement and a value of 0 indicates no agreement; a value more than 0.65 is considered acceptable. The Proportion of Agreement was more than 0.9 for all of the binary items evaluated except one (Table 18 and 19). Only one item (Have you ever suffered from excessive bleeding that has been difficult to stop?) had a k value less than of less than 0.65 (Table 19).

Continuous items were analysed by calculating the Intraclass Correlation Coefficient (ICC) and Cohen's Kappa. An ICC of 1 demonstrates complete agreement, an ICC more than 0.4 is considered acceptable and more than 0.7 is the recommended value. We used an ICC less than 0.9 as the threshold for item review. The values calculated for these 25 non binary questions are shown in Tables 18, 19 and 20.

Table 18 Kappa and PoA for binary items (1)

Question	PoA	Kappa
Do you have a responsible adult to accompany you home and stay with you for 24 hours after your operation?	0.987	0.868
Have you ever been told that you have a heart murmur?	0.987	0.902
Do you have epilepsy or take medication to prevent seizures?	0.994	0.664
Have you ever had a heart attack?	0.994	0.906
If you lie flat do you get short of breath?	0.994	0.906
Do you take any blood-thinning drugs other than warfarin? (e.g. aspirin or clopidogrel)	0.994	0.969
Have you ever had any problems with your thyroid?	0.994	0.976
Do you smoke?	0.994	0.986
Have you ever injected drugs not prescribed by your doctor?	0.994	NA
Do you take HRT (Hormone Replacement Therapy)?	1.000	1
Have you ever had any operations on your heart?	1.000	1
Are you male or female? Please tell us.	1.000	1
Do you have asthma?	1.000	1
Do you take warfarin?	1.000	1
Have you ever had treatment for heart failure?	1.000	NA
To your knowledge, do you have HIV?	1.000	NA
Have you ever had laser treatment to your eyes?	1.000	NA
Do you have a heart pacemaker or similar device?	1.000	NA
When was your last heart attack?	1.000	NA
Do you have home oxygen?	1.000	NA
Do you take, the heart drug, digoxin?	1.000	NA
Do you take methadone?	1.000	NA

Table 19 Kappa and PoA for Binary Items (2)

Question	PoA	Kappa
Do you take any medication for your blood pressure?	0.885	0.952
Do you have any neck stiffness or pain?	0.916	0.789
In the past, has anyone had any problems taking blood from you?	0.922	0.774
Do you take any medication for angina (chest pain or tightness)	0.923	0.694
Do you suffer from abnormal heart beats or are you ever aware of your own heartbeat? (palpitations)	0.935	0.788
Has a doctor changed your blood pressure treatment within the last 6 months?	0.938	0.903
Have you ever had a kidney problem?	0.942	0.695
Do you take any prescribed medication?	0.948	0.839
Have you ever suffered from excessive bleeding that has been difficult to stop?	0.955	0.565
Do you have, or have you ever had, high blood pressure?	0.955	0.897
Do you use inhalers (puffers)?	0.962	0.780
Do you regularly get sick when travelling in a car or bus? This can indicate how likely you are to feel sick after your operation.	0.968	0.797
Have you ever had liver disease? E.g. jaundice, hepatitis, cirrhosis, fatty liver	0.968	0.839
Do you ever suffer from black-outs / fainting?	0.974	0.765
Do you have any problems opening your mouth wide?	0.974	0.820
Do you take any diuretics (water tablets)?	0.974	0.868
Do you have anaemia? (Low blood count or low iron in the blood)	0.981	0.790
Have you ever been a smoker?	0.986	0.986

Table 20 Test-retest Intraclass Correlation for ePAQ-PO V2

Question	K	ICC
Have you ever had an operation?	1	
Has anyone in your family had problems with anaesthetics?	1	
Have you or a member of your family ever been diagnosed as suffering form Creutzfeld-Jakob disease (CJD)?	1	
Have you received growth hormone or gonadotrophin treatment?	1	
Do you have diabetes?	1	
Are you sure that you would not want a blood transfusion, even if it was potentially life-saving?	1	
Have you ever had TB?		1
Do you or anyone in your family suffer from any of the following blood problems?		1
When did you last have chest pain?		0.96
Have you ever had a stroke or a TIA? (a 'mini-stroke')	0.94	
Thinking about the last 4 weeks; How much alcohol do you drink in one week?		0.932
When did you stop?		0.92
Would you be willing to have a blood transfusion if it were necessary?	0.80	
Have you taken oral steroids? (e.g. Prednisolone)		0.904
Do you have a hiatus hernia?		0.862
It is sometimes necessary to give patients a blood transfusion during their operation. Have you ever had a blood transfusion?		0.846
Do you take drugs for reflux or heartburn (indigestion)? (e.g Omeprazole, Ranitidine, Lansoprazole, Gaviscon.)	0.83	
Have you ever been found to have MRSA?	0.61	
Have you ever experienced angina (chest pain from your heart)?	0.69	
Did you have any problems with the Anaesthetic?		0.784
Are you a heavy snorer?		0.773
Do you have an ongoing psychiatric/mental health disorder e.g. schizophrenia, bipolar disorder, severe depression or anxiety?	0.77	
How much do these palpitations interfere with your daily life?		0.757
Do you suffer with heartburn?	0.59	
Are you able to take Non-Steroidal Anti Inflammatory Drugs (NSAIDSs) e.g. Aspirin, Nurofen, Ibuprofen, Voltarol?	*0.53*	

ICC = Intra Class Correlation Coefficient K= Cohen's Kappa

8.3.1.3 **Patient factors and error rate**

The data was analysed to look at error rates that could be related to patient factors. As part of the initial analysis the patients were divided into groups according to the number of errors that they made. Patients who made no errors were in group 1, Group 2 contained patients that had an error rate between 0.1% and 4.9%, Group 3 had an error rate of between 5 and 9.9%. Group 4 contained patients whose error rate was equal to or greater than 10%.

Table 21 Percentage of patients within each error group that fell into each of the three error groups.

Error Group	ASA 1	ASA 2	ASA 3	Total n
Group 1	29 %	16 %	8 %	32
Group 2	45 %	55 %	46 %	77
Group 3	20 %	23 %	23 %	33
Group 4	6 %	7 %	23 %	12
Total n.	70	71	13	154

This data suggests that there may be an association between ASA grade and error rate. It appears that patients with a lower ASA grade may be less likely to make errors. However there are confounding factors and it is not clear whether this is because of the increased number of questions that higher ASA grade patients will answer or because of the complexity of the questions or because of the health status of the patients. Further investigation and regression analysis is required.

The average age of the different error groups was compared. Data was divided into the error rate groups, previously described. Mean age was calculated for each of these groups.

Table 22 Demographic characteristics of the four error groups

Error Group	Error rate	Age in years (SD)	n
Group 1	0%	50 (14.8)	32
Group 2	0.1% - 4.9%	55 (13.6)	77
Group 3	5% - 9.9%	55 (4.1)	33
Group 4	>=10%	55 (12.1)	12

There was no significant difference in the age distribution between the four error groups.

8.3.2 Comparison with face to face questioning

Comparing the patient responses with values obtained from the accepted current gold standard can assess equivalence or concurrent validity. Five questions were used to assess equivalence. These were selected because of their dichotomous nature and the lack of subjectivity in their assessment. The responses given by patients answering ePAQ-V2 were compared with the responses that the patients had provided during their face-to-face pre-operative assessment.

These questions addressed Diabetes, previous myocardial infarction, antihypertensive medication, warfarin medication and smoking status.

8.3.2.1 Results

Data from all 300 patients was included (we were unable to locate one of the face-to-face pre-operative assessment records). Some of the face-to-face pre-operative assessment records had missing data. The anti hypertensive medication question was answered by all 96 patients who had high blood pressure. 4 patients were taking wafarin medication.

Table 23 Percentage agreement between face-to-face and ePAQ-PO. This data is based on five specific questions

	Proportion of Agreement	n
Previous myocardial infarction	0.98	298
Anti Hypertensive medication	0.94	96
Warfarin medication	1	299
Smoking status	0.98	299
Diabetes	0.98	298

These data show a high level of agreement between face to face and ePAQ-PO

8.3.3 ASA score analysis

8.3.3.1 Method

The American Society of Anaesthesiologist (ASA) proposed the ASA classification of physical health system as a way of simplifying the complex and variable assessment of surgical patient's pre-operative physical health. Whilst rationalising the unlimited assessment to 5 possible outcomes the ASA system still remains notoriously subjective. However, its relative simplicity and ubiquitous usage means that it has been adopted as the most commonly used record of health status in pre-operative patients. The ASA score forms a fundamental component of many of the costing and medical accountancy systems that are utilised world-wide. Developing a more objective, patient completed, assessment that correlated well with the ASA classification system presents an opportunity to build on the success of the ASA system. A new patient completed physical health score could address the fundamental issue of subjectivity and potentially introduce a new standard in physical health assessment.

After ePAQ-PO had been completed the patients attended the routine 'face-to-face' POA clinic appointments - often on the same day. During the consultation the nurse practitioner assessed the patient's health status using a local STH pro-forma. The pro-forma covers similar questions to those asked within ePAQ-PO. The nurse practitioner documented the findings of the patient's consultation in detail, making sure all the information was accurate. At the end of the assessment the nurse practitioner evaluated the patient's assessment, and allocated an ASA grade in the box at the top of the POA pro-forma. The POA pro-forma completed by the nurse practitioners during the clinic visit was copied twice, and the ASA grade allocated to the patient by nurse practitioner was concealed using a black pen. The POA anaesthetic leads Dr M Berthoud, RHH (CA 1) and Dr A Dennis, NGH (CA 2) were each given a copy of every patient's POA pro-forma. They independently reviewed the pro-forma, and using the information documented by the nurse practitioner they allocated each

patient an ASA grade alongside the concealed score. At the end of the ASA scoring process each patient had been allocated 4 ASA grades.

ASA scores were available from five sources: face to face assessments, the two consultant anaesthetists who are experts in pre-operative assessment and also from the scoring algorithm that was applied the ePAQ Phase 3 patient data and the research nurse. The scoring algorithm was designed to function within Microsoft Excel for Mac 2008. It was subsequently translated into HTML. The original protocol also allowed for ASA scores to be generated by the research nurse who was responsible for recruiting patients. However examination of the data revealed significant inconstancies in these scores. The research nurse was asked to clarify the method that they had used to determine the ASA scores. It was apparent that the method used differed significantly from the established ASA scoring system. As a consequence of this is was decided that they should not be included in the final analysis.

8.3.3.2 **Results**

Table 24 Percentage agreement between Exact ASA scores as assigned by Expert 1, Expert 2, ePAQ and Face to Face nursing assessment based on phase 3 Data.

	Expert 1	**Expert 2**	**ePAQ**	**Face to Face**
Expert 1		72.4	63.9	60.1
Expert 2	72.4		70.7	69.3
ePAQ	63.9	70.7		66.5
Face to Face	60.1	69.3	66.5	
Total	196.4	212.4	201.1	195.9

Table 25 Percentage agreement between ASA scores when an difference of 1 is permitted between scores assigned by Expert 1, Expert 2, ePAQ and Face to Face nursing assessment based on phase 3 Data.

	Expert 1	Expert 2	ePAQ	Face to Face
Expert 1		100	99	85.9
Expert 2	100		99.7	87.9
ePAQ	99	99.7		88
Face to Face	85.9	87.9	88	
Total	284.9	287.6	286.7	261.8

Table 26 Percentage agreement between scores when they are grouped into two groups ASA1 and 2 and a second group ASA 3 and 4. Scores were assigned by Expert 1, Expert 2, ePAQ and Face to Face nursing assessment based on phase 3 data.

	Expert 1	Expert 2	ePAQ	Face to Face
Expert 1		85.9	84.0	85.0
Expert 2	85.9		86.6	87.9
ePAQ	84.0	86.6		88.0
Face to Face	85.0	87.9	88.0	
Total	254.9	260.4	258.6	260.9

The analysis was impeded by a significant number of missing data sets. The pre-operative assessment nurses had failed to assign an ASA score or had assigned multiple ASA scores to individual patients. This complicated the analysis and potentially introduced bias.

Data from the face to face pre-op assessments was incomplete. Of the 300 patients, one did not have an assessment, leaving 299 of the remaining 299 patients 61.4% had a valid ASA score and 33% had no score assigned. Of the cases not scored by the face to face pre-op assessment clinic, the ASA score most frequently allocated by the two consultant leads was ASA2, then ASA1 and lastly ASA3 (table 4). The percentage of cases in each ASA category was in keeping with each consultant's pattern of ASA allocation suggesting that these cases were no different to the rest of the study population.

Table 27 ASA scores assigned to Phase 3 patients by the nurses in pre-op assessment clinic at RHH who undertook face to face assessments

ASA Score	Number of patients (%)
ASA 1	54 (18)
ASA 1 - 2	11 (3.7)
ASA 2	120 (40)
ASA 2 - 3	5 (1.7)
ASA 3 - 4	9 (3.0)
Not scored	98 (32.7)

The analysis was repeated with missing and duplicated items removed from all comparisons. The following results were generated from the remaining 176 patients.

Table 28 Percentage agreement between Exact ASA scores as assigned by Expert 1, Expert 2, ePAQ and Face to Face nursing assessment based on filtered Phase 3 Data.

	Expert 1	Expert 2	ePAQ	Face to Face
Expert 1		75.0	65.3	61.9
Expert 2	75.0		68.8	69.3
ePAQ	65.3	68.8		66.5
Face to Face	61.9	69.3	66.5	
Total	200.4	213.1	200.6	197.7

Table 29 Percentage agreement between ASA scores when an difference of 1 is permitted between scores assigned by Expert 1, Expert 2, ePAQ and Face to Face nursing assessment based on filtered Phase 3 Data.

	Expert 1	Expert 2	ePAQ	Face to Face
Expert 1		100.0	99.4	98.0
Expert 2	100.0		99.4	99.0
ePAQ	99.4	99.4		97.5
Face to Face	98.8	99.0	97.5	
Total	298.2	298.4	296.3	294.5

Table 30 Percentage agreement between ASA scores when they are grouped into two groups ASA1 and 2 and a second group ASA 3 and 4. Scores were assigned by Expert 1, Expert 2, ePAQ and Face to Face nursing assessment based on filtered Phase 3 data.

	Expert 1	**Expert 2**	**ePAQ**	**Face to Face**
Expert 1		85.8	84.6	84.6
Expert 2	85.8		85.2	88.6
ePAQ	84.6	85.2		88.0
Face to Face	84.6	88.6	88.0	
Total	255	259.6	257.8	261.2

These results indicate that there is a high level of agreement between consultant leads for pre-operative assessment and ePAQ-PO. This would appear to be greater than the level of agreement with pre-operative assessment nurses. However this difference is unlikely to be statistically significant.

The pre-operative assessment nurses did not assign ASA scores to a large number of patients. When the pre-operative assessment sheets were reviewed it was clear that this was more likely to occur with more complex patients. The presence of a significant life threatening illness such as cancer seemed to result in the nursing staff being less likely to assign a single ASA score. Patients that had major surgery planned were also less likely to have ASA scores assigned. As ASA score is known to be highly subjective it is to be expected that there is discrepancy between the scores. It is interesting that when the ASA scores are grouped into brackets there is less agreement than when the ASA scores are permitted to be 1 ASA score different. This may be because the distinguishing difference between an ASA score of 2 and 3 is whether the systemic illness has an impact on the patient's functional status. This assessment is significantly more subjective than the difference between ASA 1 and ASA 2.

Safety is a key requirement of any scoring systems. It is generally accepted that any automated scoring system should be more conservative and therefore safer than human judgement. As a way of assessing this, the relative frequency of ASA scores assigned by each scorer was calculated.

Table 31 Percentage of patients that are assigned a particular ASA score by each of the scorers. All patients from phase 3 were included in this analysis. n=299

	Expert 1	**Expert 2**	**EPAQ**	**Face to Face**
ASA 1	30.1	27.3	18.2	29
ASA 2	52.3	59.1	68.2	66.5
ASA 3	17.6	13.6	13.6	4.5

Correlations coefficients were calculated between all scorers. All correlations were positive at the 0.01 level (2-tailed). All data was included in this analysis.

Table 32 Correlation coefficients for ASA scores assigned by different scorers. All phase 3 patients were included in this analysis n=299

	Expert 1	**Expert 2**	**EPAQ**	**Face to Face**
Expert 1	1	0.71	0.55	0.47
Expert 2	0.71	1	0.55	0.54
EPAQ	0.55	0.55	1	0.41
Face to Face	0.47		0.41	1

* correlation is significant at the 0.01 level. (2 tailed)

Table 33 ASA group (as assigned by ePAQ) and Age distribution

	Mean Age (yr.)	St.Deviation (yr.)	Range (yr.)	N.
ASA 1	50	14	26-73	29
ASA 2	54	14	18-79	66.5
ASA 3	55	15	21-80	4.5

Table 31 shows that there was no significant difference in age between the three ASA groups. In the sample included in this study, ASA would appear to be independent of age. However, this may be because the study was conducted in a tertiary teaching hospital with a population that was more unwell than the general population. In a larger wider sample a difference may be seen, this is because ASA is related to co-morbidities and older patients are more likely to have developed illness.

8.3.4 Height Weight Data ASA analysis

8.3.4.1 Method

As part phase 3, patients were asked to estimate or measure their height and weight and enter this into the ePAQ questionnaire. All patients subsequently attended their routine face-to-face preoperative assessment appointment where they were weighed and measured. One hundred and fifty patients completed ePAQ-PO a second time for test–retest validation.

8.3.4.2 Results

The resulting mean (SD) differences between patient self-reported and measured data for weight, height, and BMI were -1.3 (8) kg, 2.1 (3) cm, and -1.1 (2.6) kg/m^2, respectively. World Health Organization (WHO) BMI classification was correctly self-estimated in 78% of patients and was within one WHO category in a further 21%. Test–retest ePAQ-PO data were available for 138 patients. One patient, who recorded their height as 2 cm, was removed from this data set. The test–retest mean (SD) score differences for weight, height, and BMI were 0.55 (10.2) kg, -2.2 (16.99) cm, and 1.2 (11.9) kg/m^2, respectively. Patients tended to under-report their weight (Figure 9) and over report their height (Figure 10), but the resulting BMI error (Figure 11) was rarely clinically significant. Our web-based questionnaire gives similar results to patients' self-reported height and weight obtained using a telephone survey. Web-based self-reporting appears to give accurate estimates of patients' height and weight. The limits of agreement for all measures were skewed by one erroneous results that was incorrect by a factor of 10.

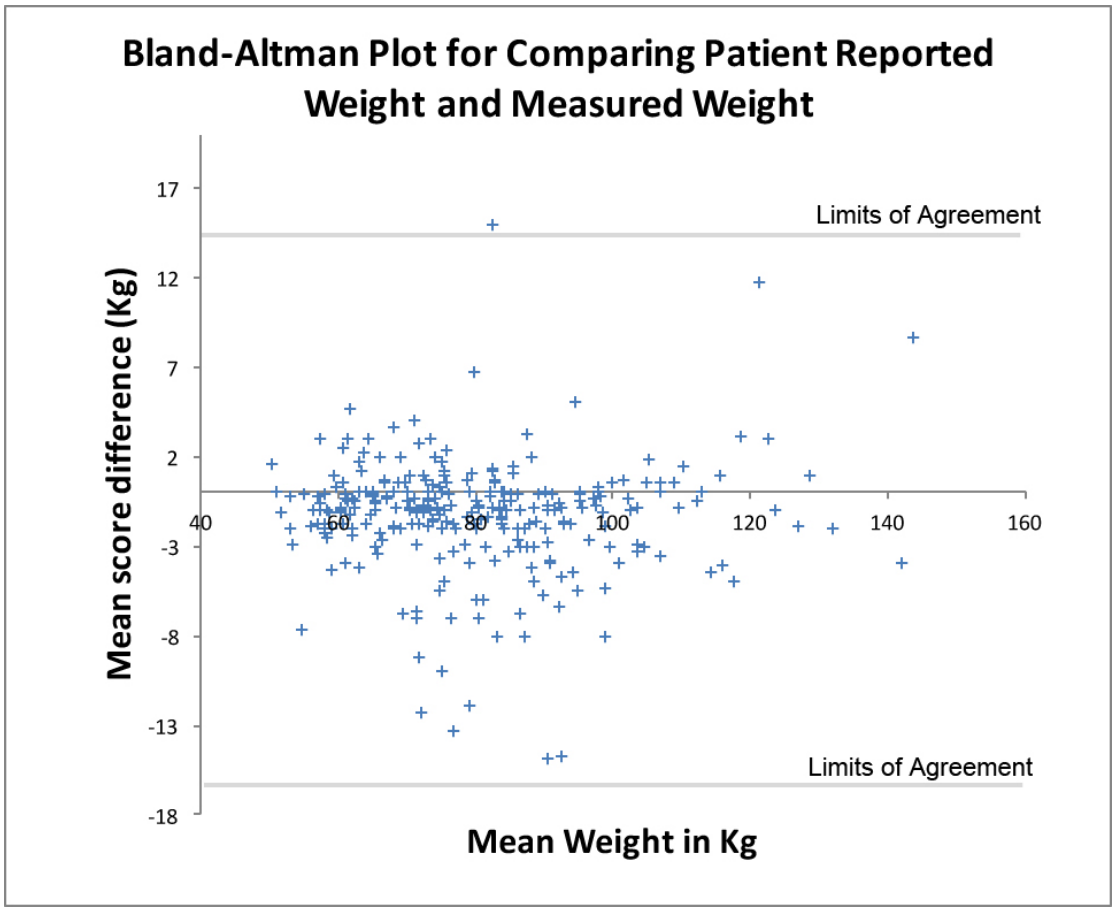


Figure 9 Bland-Altman plot comparing patient reported weight and actual weight measured in the face to face pre-operative assessment clinic.

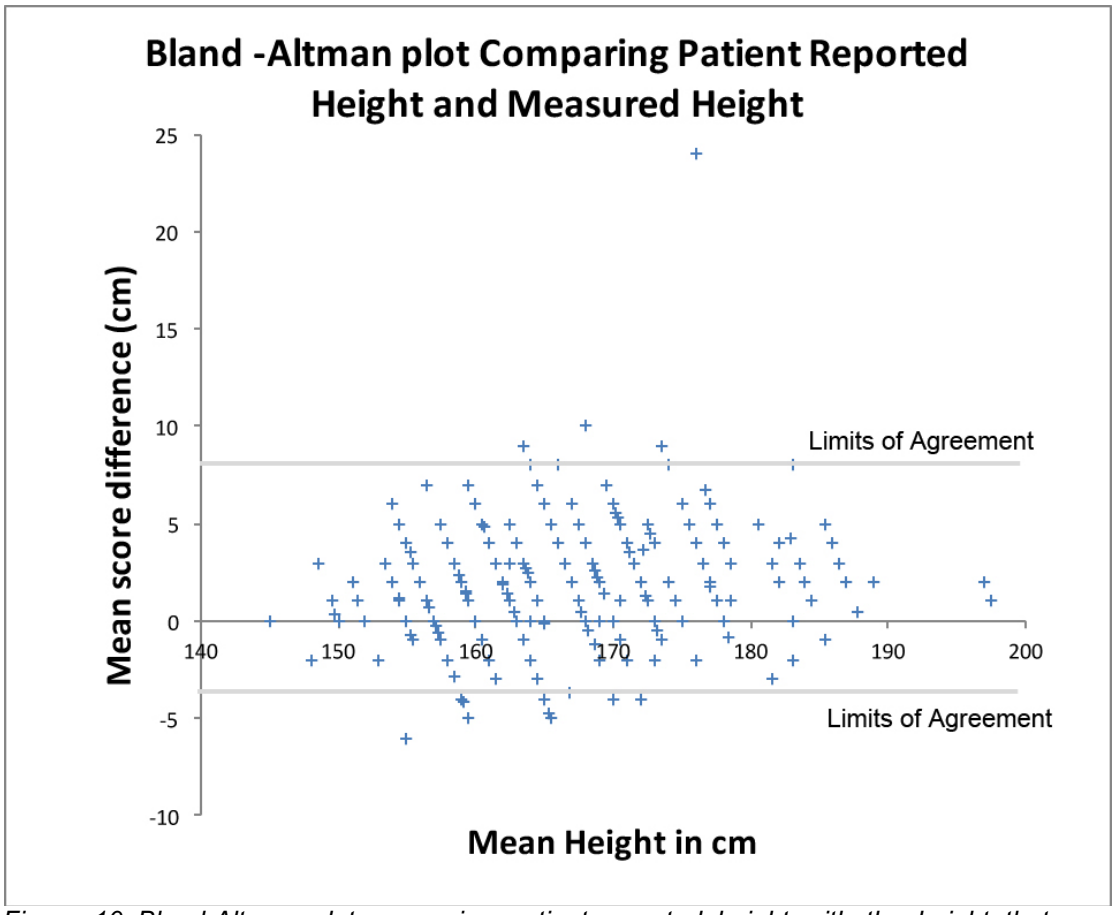


Figure 10 Bland-Altman plot comparing patient reported height with the height that was measured in the face to face pre-operative assessment clinic.

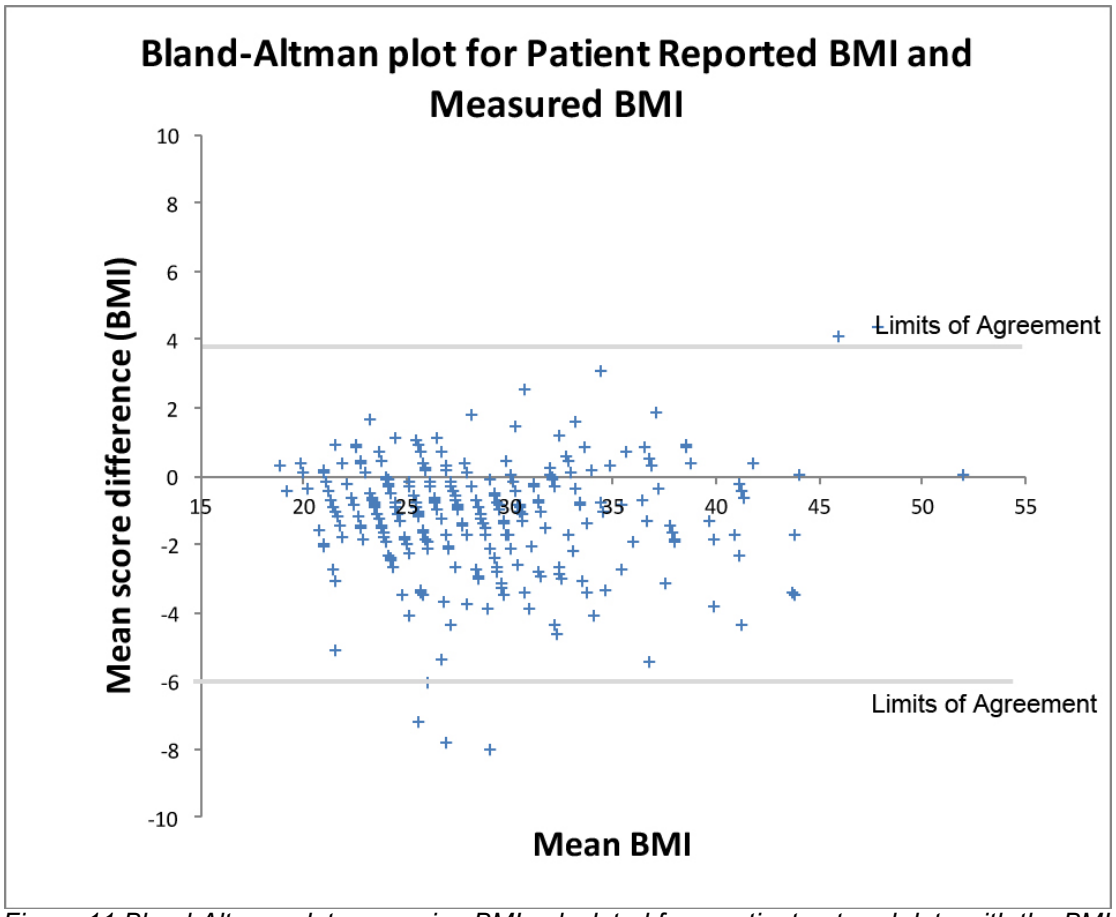


Figure 11 Bland-Altman plot comparing BMI calculated from patient entered data with the BMI calculated from height and weight measured in the pre-operative assessment clinic.

8.4 Discussion

The low error rate and high concordance with data that was collected in the traditional manner would suggest that the system is valid and reliable. However, some questions had a significant error rate. These questions have been rewritten and are thought to be more reliable now. Further work is needed to establish if this assumption is correct. Further analysis of the data is needed to establish if there are any patient specific factors which influence error rate.

The algorithm applied to ePAQ-PO version 2 data appears to be able to generate an ASA score that is at least as reliable as the ASA score assigned by pre-operative assessment nurses.

While this work has established that on-line pre-operative assessment can be used to supplement the face-to-face pre-operative assessment and that it can be used to establish a measure of health status (ASA) it is not possible to say that this system can replace face to face assessment. The impact that ePAQ-PO has on a real pre-operative assessment clinic has not been established but the work that will follow intends to assess what impact ePAQ-PO may have on a real pre-operative assessment clinic.

9 Time and motion

A baseline measurement of the flow of patients though the anaesthetic pre-operative assessment clinics at Sheffield Teaching Hospitals NHS FT has been conducted:

9.1 Methods

This service evaluation was performed with the agreement of the clinical effectiveness department, and pre-operative assessment units at STH.

Data was collected on two sheets of paper, one which the patient carried around the clinic and the second which was attached to the patient notes. The sheet carried by the patient recorded the roles of the health care professionals that the patient saw and the number of times that they saw these professionals. Information about journey times and costs was also collected. The second sheet recorded data about the time that nurses spent dealing with tasks which did not require the patient to be present in the room.

120 data collection sheets were handed out at the RHH, 60 were handed out at the NGH. NGH data collection took place between 27th April 2012 and 1st May 2012. RHH Data collection took place between 9th and 14th May 2012. In total 175 data collection sets were returned.

9.2 Results

There were 71 obvious timing errors and omissions where the start time was not documented or the start times of one activity overlapped with the finish time of another activity. 1397 Time points were recorded on the results database, 71 (5%) of these had to be corrected to allow calculations to be made, the times were corrected by assuming that the start time of the next event was the same as the finish time of the preceding event. These corrections had the effect of changing a negative waiting time to a nil waiting time or reducing duration of a clinical encounter.

Table 34 Summarising the number of patients included in the service evaluation of pre-op clinics at STH and the distance travelled and time spent in clinic

	NGH	RHH
Number of patients	57	118
Average no. of encounters with staff (range)	3 (1-5)	4 (1-6)
Length of time spent in clinic h:mm (SD)	1:33 (32)	1:46 (38)
Time spent with health care professionals	1:09 (21)	0:57 (28)
Time spend waiting	0:24 (16)	0:49 (25)
Distance travelled miles one way (range)	11 (1-60)	13 (0-100)
Time spent travelling (min) one way, (range)	39 (2-90)	44 (1-120)

Patients see a number of different health care professionals when they attend the clinic.

Table 35 Waiting times and consultation times for the various health care professionals that work within the pre-operative assessment clinics at STH

Health Care Professional	RHH Wait	NGH Wait	RHH Time	NGH Time
CSW	11:46 (213)	5:10 (94)	8:49 (213)	8:45 (94)
SN	21:27 (27)	6:48 (45)	31:49 (27)	11:51 (45)
NP	19:26 (128)	10:23 (57)	27:54 (128)	44:47 (57)
Physio	03:30 (4)	N/A	19:00 (4)	
Dr	1:00 (5)	N/A	11:00 (5)	

Times in minutes and seconds, (N)
At the RHH the mean number of clinical encounters was 4 at the NGH the mean number was 3. CSW = Clinical Support Worker, SN = Staff nurse, NP = Nurse Practitioner, Dr = Doctor

These are summary stats and do not reflect the duration of the different tasks performed. Nurse Practitioners (NP) performed the majority of assessments at the RHH. Some assessments were performed by the Staff Nurses (SN) these were reviewed by NP. At the NGH the majority of assessments were done by NP and many of the bloods were done by SN. This difference in activity affects the average times displayed for each professional group and needs to be further analysed.

Patients undergo a number of different tests and assessments when they attend the pre-operative assessment clinic. Inevitably there are delays before

seeing each of these practitioners. The data collected allows this to be explored in more detail.

Table 36 Waiting times and consultation times for the various tests and assessments that occur within the pre-operative assessment clinics at STH

Test/Assessment	RHH Wait	NGH Wait	RHH Time	NGH Time
OBS & SWABS	16:39 (105)	06:00 (53)	10:29 (105)	9:24 (53)
ECG	07:30 (61)	0:00 (1)	07:30 (61)	5:00 (1)
ASSESS	22:09 (96)	10:44 (44)	33:40 (96)	41:38(44)
EXAMINATION	13:11 (21)	07:00 (2)	09:20 (21)	16:30 (2)
RFTS	23:00 (1)	03:23 (8)	15:00 (1)	08:37 (8)
BLOODS	05:23 (76)	05:37 (45)	06:59 (76)	07:59 (45)

Times in minutes and seconds, (N)

Patients see a number of different health care professionals when they attend the pre-operative assessment clinic. Inevitably there are delays before seeing each of these practitioners. The data collected allows this to be explored in more detail.

Table 37 Waiting times and consultation times for the various clinical encounters that occur within the pre-operative assessment clinics at STH

Clinical Encounter	RHH Wait	NGH Wait	RHH Time	NGH Time
1st	16:00 (118)	06:00 (57)	10:00 (118)	10:00 (57)
2nd	20:00 (117)	10:00 (56)	28:00 (117)	42:00 (56)
3rd	08:00 (97)	06:00 (46)	13:00 (97)	12:00 (46)
4th	06:00 (58)	02:00 (30)	08:00 (58)	10:00 (30)
5th	05:00 (20)	10:00 (10)	13:00 (20)	10:00 (10)
6th	02:00 (4)		20:00 (4)	

Times in minutes, (N)

Nurses, health care assistants, students and doctors staff the pre-operative assessment clinics. There is a high level of staff flexibility, whilst these results in a smooth experience for the patients, highly skilled staff are performing tasks that could be performed by staff with less training.
Delegation of tasks to less skilled member of the team may free up more experienced staff to perform more complex tasks and create efficiency savings. The data collected allows this to be examined.

Table 38 Summarising which tasks are completed by the different staff groups in the pre-operative assessment clinics at STH

Staff Group		Activity at NGH	Activity at RHH
CSW	(NGH N = 95) (RHH N = 220)	Obs & Swabs - 43% Bloods - 42% RFTS - 8%	Obs & Swabs 46% Bloods - 28% ECGs - 19%
SN	(NGH N = 45) (RHH N = 28)	Assessment – 22% Contact Assess – 42% Obs & Swabs 22% Bloods 11% ECG – 2%	Assessment – 68% Bloods – 14% Obs & Swabs – 11%
NP	(NGH N = 57) (RHH N = 130)	Assessment – 68% Assessment & ECG - 23% Check assessment - 3% Examination - 3%	Assessment – 57% Assessment & Bloods – 14% Examination - 16% Bloods – 8%

CSW = Clinical Support Worker, SN = Staff nurse, NP = Nurse Practitioner

All patients checked in with reception staff when they arrived in the clinic. They confirmed their name, address and phone number at that point. Patients then move on into the main clinic area where it was anticipated that they would see a clinical support worker. However this was not always the case, the staff member that they then saw varied.

Table 39 Summary Table showing the sequence in which patients see different clinical staff members in the pre-operative assessment clinics at STH

Staff Group	Activity at NGH	Activity at RHH
1st (NGH N = 57) (RHH N = 118)	CSW – 75% SN – 19% NP – 4%	CSW – 96% NP – 1% SN – 3%
2nd (NGH N = 56) (RHH N = 117)	NP – 84% SN – 14% CSW – 2%	NP – 67% SN – 16% CSW – 9.4%
3rd (NGH N = 48) (RHH N = 95)	CSW – 71% SN – 17% NP – 13%	CSW – 60% NP – 30% ECGT – 5% SN – 2.1%
4th (NGH N = 27) (RHH N = 58)	CSW – 82% NP – 13% SN – 5%	CSW – 53% NP – 26% SN – 5% PHYSIO – 5% ECGT 3%
5th (NGH N = 10) (RHH N = 20)	CSW – 59% SN – 37% NP – 4%	CSW – 82% ECGT – 15% NP – 13% PHYSIO – 5% X-RAY – 5%

9.3 Discussion

The majority of delays in the clinic occur early in the patients' journey through the clinic. This is generally when they are waiting to be assessed by the nurse practitioners or staff nurses. Delays also occur when the patients first arrive and are waiting to have swabs and observations completed. There is a significant wait associated with needing respiratory function tests (RFTs). But the number of RFTs performed is low so the overall impact on clinic efficiency is likely to be minor.

There are differences in the way that the two clinics undertake ECGs. At the NGH ECGS are mainly done by nursing staff during the main assessment, at the RHH ECGs are done by CSWs. This may have led to the increased average time needed for NP and SN assessment at the NGH

Having blood tests taken in the clinic increases the patients stay by more than 10 minutes. Bloods tests are nearly always completed after the NP/SN assessment.

It would seem likely that if the NP and SN assessments can be made shorter the wait before seeing the nursing staff could be reduced. This may permit an increased clinic throughput and reduction in the number of patients in the clinic at any one time.

9.4 ASA and time to undertake pre-operative assessment

Nursing staff at the STH pre-operative assessment clinics have been collecting data which records the time taken to see the patient and the ASA status of the patient. Data from a total of 8519 patients undergoing standard face to face pre-operative assessment was available for assessment.

Twenty nurse practitioners recorded the age, speciality, estimated ASA grade of the patients and also the duration of consultation.

Data was analysed using SPSS 21 and subjected to ANCOVA, the Peasrosn product-moment correlation, and regression analysis.

Two hundred and twenty-one patients were excluded from analysis because the time data was incomplete. The mean (SD) age was 52 (18.1) years. 55.8% were female. 20.9% were ASA I, 55.5% ASA II, 22.5% ASA III, and 1.1% ASA IV.

The mean (SD) assessment duration for all patients was 47 (16) min and for each ASA group, the mean duration was: ASA I 36 (12), ASA II 46 (14), ASA III 58 (17), and ASA IV 63 (19).

The duration of a preoperative assessment with a nurse practitioner increases with increasing ASA status ($P<0.001$). Regression analysis revealed an 11 min increase in assessment time for each progressive ASA grade.

This assessment has been undertaken in advance of questionnaire implementation. It is anticipated that this analysis will be repeated after full roll out of ePAQ-PO. Further data is being collected with the aim of assessing the impact of ePAQ PO on the time that is needed for a pre-operative assessment.

10 Final Discussion

10.1 Limitations of the literature review

This project was started in 2013. At this time the cost of touch-screen technology was falling rapidly and it was becoming increasingly available in the public domain. In the 10 years prior to undertaking this project I had previously undertaken work developing touch-screen questionnaires for pain assessment and QOL. These questionnaires were developed for use in the Endocrinology, Oncology and Psychology departments of the University of Sheffield. The most recent of these questionnaires was completed in 2009. When conducting the literature search for this project, I was keen to see if the recent technological advances were reflected in an increase in research and development activity. In my previous quality of life projects I conducted literature searches and created cumulative frequency charts that demonstrated a year on year increase in research activity in the 1970's and 1980's which then subsided in the late 1990's. I was keen to see if this could be reproduced with this study. I anticipated finding an increase in publications that reported touch-screen technology in the years 2004 to 2013. However, the number of papers that I found was lower than I had expected and I therefore simply separated studies based on the arbitrary date of 1st January 2009. In hindsight, I should have considered widening my search, including quality of life research and also including non-medical applications of touch-screen technology. In addition, I noted the impact that spelling variations had on the search success. It would have been worth conducting the search using standardised MESH headings. Also although our plan was to construct the questionnaire in English, I should have searched for questionnaires and papers that were not written in the English language. Repeating the literature search using these terms would probably have yielded more responses.

Phase 1 and 2 of the project were conducted over a 2 year period. The time and motion analysis and assessment of ePAQ-PO in a live clinical setting was conducted during the following 2 years. It would have been interesting to repeat the search again towards the end of the project to establish if further work had

been undertaken by other groups. This may have yielded useful papers that may have helped us achieve more effective uptake and implementation.

10.2 Evidence for or against the use of touch-screen questionnaires and factors affecting usage

At the outset of this project the use of touch-screen technology in patient assessment was uncertain. The three largest barriers to the uptake of computerised technology appeared to be the cost of software development and concerns over information governance and capital investment in devices (94). The mass proliferation of smart-phone technology and touch-screen enabled devices has facilitated the use of computerised questionnaires in many health care settings for patient education, monitoring, and data collection. Global awareness of information governance and the development of transferrable information governance toolkits has smoothed these barriers. The computing power of smart phone devices is sufficient that they can be considered as mobile computers in their own right (95). As a result multiple publications now support the use of computer technology in patient surveys (19, 32).

However, caution should be exercised when developing and implementing new questionnaires. Careful planning, preparation and engagement with IT departments, clinicians and patient representatives is essential. Consideration should be given to the work streams and standard operating procedures of the departments that the questionnaire is going to be deployed in. In large hospitals with multiple different surgical specialities it is possible for patients to be listed and prepared for surgery in multiple different ways. Some teams retain sole responsibility for pre-operative assessment whilst others delegate to centralised pre-assessment services. Involving service improvement teams and system analysts can help with modelling patient and information flow. Having defined current processes it is possible to predict the impact that new systems can have. It is then possible to test potential stresses and risk assess failures in the new system. Undertaking this sort of careful planning and

evaluation prior to software development can minimise costly post development software modification.

My study intended to; develop a patient completed pre-operative assessment questionnaire, create an electronic and patient-completed version of this questionnaire, ascertain the validity and reliability of the electronic questionnaire and establish whether it was feasible to use the electronic questionnaire in routine clinical practice. Given the advances in computer technology and the increasing availability of the necessary programming skills I believe that we have shown that there is a future for the use of touch-screen and computerised questionnaires, that they can be developed cost effectively and can produce valid and reliable data.

10.3 General limitations of preoperative questionnaires for predicting perioperative risk?

The work completed to date indicates that ePAQ-PO could be a valid and reliable tool. Further analysis of the data and the application of robust statistical tests are needed to confirm this and to establish to what extent the data from the questionnaire can be relied upon. Factor analysis might have allowed the structure of the questionnaire to be confirmed and identified redundant items or errors in the way that the questionnaire is structured. However, factor analysis was not possible because of the design of the study.

This study shows that the questionnaire appears to be a valid measure that covers the key areas required in a thorough pre-operative assessment. These data can be used to risk stratify patients into the crude and subjective ASA categories. However, the questionnaire is not exhaustive and cannot replace a thorough face-to-face discussion, particularly for patients with complex health issues. ASA scores are known to be highly subjective. Although not perfect, the ePAQ ASA score appears to be comparable with other validated electronic ASA scoring systems.

Analysis of the risk assessment scores LEE, SF12, ASA and the ePAQ data may enable a new alternative objective score to be generated that may be able to replace the crude and subjective ASA assessment scheme. SF12 and LEE data were collected as part of this study but time constraints and off site data storage have meant that they have not been included in this work. Future analysis may allow these scores to be used to identify high risk patients that would benefit from pre-operative optimisation or pre-emptive admission to critical care environments.

While it is clearly feasible to develop an on-line tool to replace a tick box paper questionnaire the key issue is how this system is implemented in clinical practice and what impact this has on the pre-operative assessment clinic. This impact can be assessed in terms of quality and efficiency. Further work is needed to establish this. There may be potential concerns that there is an agenda to replace pre-operative assessment services with the on-line questionnaire. This will have a significant impact on the success of an implementation programme.

Although the ASA score can be considered an over simplification of health status all patients should have ASA assessment preoperatively and this study highlights the deficiencies in current face-to-face assessments and indicates that ePAQ-PO can support the assessment of ASA grade. Our findings are in line with other studies investigating the utilisation of computer- assigned ASA grades. Zuidema et al. also demonstrated a high level of agreement between computer-assigned ASA grades and caregiver-assigned grades. However, in contrast to the findings in this study, Zuidema et al. reported that the SynopsisIQ computer system- assigned grades underestimated ASA.

Whilst it is possible to score and categorise isolated assessments of function or ASA it is the global functional reserve that frequently influences decisions about anaesthetic technique and post-operative care. Patient completed questionnaires that attempt to assess functional status objectively have been developed. The Duke Activity Status Index (DASI) is one such questionnaire (96). These questionnaires are more commonly used when assessing

responsiveness to treatment of conditions such as angina or COPD (97, 98), rather than risk stratifying or predicting post-operative outcomes.

10.4 Physical fitness and surgical procedure on outcome after surgery, resource allocation and risk.

Cardio-pulmonary exercise testing (CPET/CPEX) is considered by many to be a reliable and objective test for the evaluation of functional capacity (99). CPET/CPEX is used in many centres to select patients for surgery based on the predicted chance of post-operative complications (100). CPET/CPEX testing provides multiple measures of cardio-respiratory function and there is variation in the way that it is used, with debate as to which measured or derived parameter best predicts adverse outcome (101).

Other validated measures of global pre-operative functional status exist. These include the 6 minute walk test (102) and Incremental shuttle walk test (ISWT) (103, 104).

Given that physiological reserve and physical fitness may impact on post-operative complications and recovery, some centres have introduced pre-operative physical training and 'fit clubs' as part of the process of pre-operative optimisation. Whilst benefit has been established in some fields this is not universal and it is not clear as to whether the benefit is as a result of weight loss, improved muscle strength or improvement in cardiovascular reserve.

On balance there is a valid role for the use of screening questionnaires in the categorisation and selection of patients in whom more invasive or costly investigations are warranted. This approach is encouraged by Palda and Detski in their assessment of factors that contributed to increased risk of cardiac complications (105) with many centres combining questionnaire data with functional tests (106). Struthers compared CPET/CPEX, ISWT and DASI (71).The team established a significant correlation between the three measures but that some patients with a poor DASI score were allocated to the low risk

group on CPET/CPEX testing. Struthers concluded that; neither simple test (DASI/ISWT) had the ability to determine risk, CPEX/CPET provided an objective measure of fitness but that there was limited evidence that this improved outcome.

There remains a relative paucity of evidence linking pre-operative health status in a heterogeneous population, to post-operative functional outcomes and post-operative quality of life. Whilst research papers and scores often focus on individual risk factors, defined surgical groups or specific complications, our clinical decisions and management are more often based on a general assessment of function and the intention to maintain and improve overall quality of life. Post-operative outcomes such as discharge home, post-operative employment status or discharge to nursing or residential care, are arguably more significant to both the individual and society. Further work to assess the impact of pre-operative health status on functional outcomes is warranted. A universal, systematic, objective patient completed questionnaire (like ePAQ-PO), used in conjunction with a broad assessment of outcomes may allow the collection of large data sets that could facilitate the creation of predictive models.

10.5 Sample size, the statistical tests and potential sources of bias

The original sample size calculations were based on assumptions that the questionnaire would be of limited size, that patients would have more than 3 response options and that the questionnaire would be presented to the patients in a linear, non-branched fashion. Advice from statisticians and social scientists was sought at the time of writing the original protocol and study design. However, as the study progressed there was significant deviation from the original design. There were a number of opportunities to pause the study, seek further advice and repeat the sample size and power calculations. These opportunities were not used and the study suffered as a result. Had advice been sought, it may have been possible to seek an amendment to the ethics approval and obtain an increased sample size. However, this would have significantly lengthened the duration of the study and there were insufficient funds.

The value of this project relies heavily on the ability of the questionnaire to accurately record patient entered height and weight data and assign ASA scores. These factors were not considered when initial estimates of sample size were made. As a result, the measure of reliability was based upon mean score difference, positive correlations and comparing results with the findings of other published works. It would have been more appropriate to start by defining clinically acceptable limits for variation and then establishing a sample size based on these limits. I have attempted to apply Students T test to the study data. I could not established a significant probability value when comparing the means of any of the groups that were compared. Given the limited number of outcomes from the ASA calculation and the likely variation in scores, a much larger sample size would be needed to establish the presence or absence of a true statistically significant difference.

The questionnaire was designed and validated by the same team. This presents the potential criticism that the team may have been open to bias. The study design was intended to prevent this. However, there was significant variation from the original study design. This variation occurred because of difficulties with recruitment and a conflict of interests between study design and software design. It was not done with the intention of altering the findings of the study. The impact of this was to degrade the integrity and value of the study.

Data was collected in an objective way with no opportunity for bias in patient selection. However, the two experts in pre-operative assessment assigned scores based upon their interpretation of the nursing documentation. I reported these data as though they were equivalent to the ASA scores that would have been assigned as a result of an anaesthetic assessment of a patient's health status. In retrospect I realised that this actually introduces bias as the anaesthetic consultants' assessment is based upon the nursing staff's record of health status. Interestingly though, when the nursing staff ASA scores were compared with the consultant assigned scores there was a lower correlation than there was between the ePAQ and consultant scores. Given that the

consultant scores were dependant on the nursing documentation, I would have expected a higher level of correlation.

There were significant amounts of data collected that were not used. We did not use the SF36 data or the LEE scores. This was in breach of the original study design. It would have been useful to establish if there was an association between these scores and the ASA scores obtained in this study.

The ability of the system to accurately predict ASA scores is an important feature of an electronic pre-operative assessment questionnaire. However, errors in the conduct of the study limited our ability to determine whether the questionnaire can achieve this. One of these errors was in the training of the research nurse. The research nurse was told to assign an ASA score of 3 to any patient with a pituitary tumour, irrespective of the presence or absence of any other diseases. As a large proportion of the patients were undergoing neurosurgery for pituitary tumours, this invalidated the data obtained from these patients. In addition, I had not appreciated that it was standard practice for the pre-operative assessment nursing staff to assign multiple or half scores (ASA2/3 or ASA 2.5) to patients that they were finding challenging to categorise. We had not established a strategy for dealing with this when we designed the study.

10.6 Limitations of the data and study design

Funding was obtained from NHS England and Sheffield Hospitals Charity. However, there was only sufficient funding to support the cost of software development/hosting and the nursing staff time provided by the clinical research facility at the Royal Hallamshire Hospital. Evaluation of the questionnaire therefore required adoption and implementation by the trust on the basis of service improvement, innovation and development. As a result there was constant tension between the academic priorities (maintaining academic integrity, data quality, adherence to the study protocol and statistical validity) and the clinical and commercial pressures on the hospital. This had overwhelmingly negative effects on the study. We were required to establish

that the questionnaire would have minimal impact and burden on the patients and clinic staff before we could use it in the clinics. This meant that we had to incorporate the branched structure at the outset of the study. As a result we were unable to apply the planned factor analysis technique and we were unable to confirm the domain structure.

We had intended to measure the time taken for patients to complete the questionnaire and establish if there was a significant learning effect. However, poor rates of recruitment meant that we had to allow patients to complete the questionnaire remotely and we could not record the completion times. Completion times could not be obtained from the electronic database because the system allowed patients to pause the questionnaire and return to it at a later date. When constructing commercial on-line questionnaires and web pages it is common practice to embed code that tracks mouse position and movement. This data allows advertisers and website developers to assess viewer focus and attention. It is possible to use this same code in patient questionnaires, but the collection of this data, without explicit consent, may be considered a violation of the patients privacy.

One measure of validity was test-retest between questionnaire completions. We did not include an objective assessment of change in health status between completions and therefore it was not possible to establish if differences were because of data errors or true change in health status. It would have been wise to include a measure that could be relied upon as a gold standard and then compared the data obtained by the face to face assessments and ePAQ-PO with this gold standard.

Later in the study I attempted to evaluate the use of the questionnaire in the real population. However, as we had no funding to support the research at this stage, we did not collect data that would have allowed us to establish the reasons for poor uptake. This is a major weakness, it would have provided us with useful information that would have benefited this project and other research groups. This also leaves us open to criticism as the boundary between service improvement and research becomes blurred.

I undertook this work alongside my clinical training without any protected or funded time. This was challenging and presented significant difficulty when balancing training priorities with research interests. In undertaking this work, and reflecting on the significant weaknesses in it, I have learned how important it is to have protected time and access to multidisciplinary support when undertaking research.

The study was conducted without specific funding to cover the time of the research team. This meant that the team had to squeeze meetings around their clinical commitments or attend work on non-working days. This resulted in variable attendance at planning meetings and some decisions had to be taken without input from all the appropriate experts. There is no doubt in my mind that this contributed to errors in the study design and confusion as to the plan for data collection and analysis. This full extent of this problem did not become apparent until the point of data analysis. At this stage it was too late to collect the data needed to resolve the problem. When designing future studies I would endeavour to make sure that all the team were able to attend planning meetings, that there was funding to support this and that we had a process for ensuring that key aspects of the study had been reviewed by all the relevant experts. I would also consider undertaking a desk based simulation of the study as a way of identifying potential problems. It may have also helped us to introduce some interim analysis steps.

10.7 Translation to other sites

The time and motion data at STH highlights the problem with defining the impact that the questionnaire would have on a pre-operative assessment clinic. The impact of the questionnaire is likely to be dependent on the structure of the system into which it is going to be integrated. There is a high degree of heterogeneity between pre-operative assessment clinics even within the same NHS trust. This makes it difficult to establish a bench mark against which success can be judged. As there is likely to be even greater differences in other trusts it makes it even harder to predict the effect that it will have in these other

sites, further service evaluation and testing in other sites would help establish the true value.

Another significant factor that might influence adoption at other sites is the increasing adoption of electronic patient records. It is commonly assumed that adoption of one electronic systems enhances the enthusiasm for adoption of others. However successful adoption of electronic patient record systems is reliant on trust wide support, modification of work flows and streamlining data storage and integration. Each additional electronic system adds complexity and burden to the process of integration. The electronic patient record is such a significant investment and is so fundamental to the smooth and safe function of a hospital that it will take priority over all other systems. IT departments will normally seek to minimise burden and additional expenditure by trying to use the electronic patient record system to deliver the functionality previously provided by other suppliers. In many cases this is achievable but with patient facing systems (like ePAQ-PO) there is a risk that features designed to facilitate interaction and accessibly may be lost. This has the potential to degrade data quality, limit utilisation and reduce reliability. The use of a questionnaires in third party software can also raise challenges with intellectual property rights.

11 Conclusion

The work undertaken so far suggests that patient completed on-line computerised questionnaires provide valid data and are acceptable to a significant proportion of the patient population. However, a large number of 'real' patients did not complete the questionnaire; further work is needed to establish the reasons for this.

While the face validity, test-retest and convergent validity have been established the true domain structure has not been formally assessed. There were significant errors in study design and conduct. The next stage in development is to establish scoring systems that can be used to guide decision-making algorithms. In order to do this properly the domain structure should be confirmed either by using a post hoc analysis technique or repeating phase 2 with an unbranched version of the questionnaire.

12 Future Work:

12.1 Reasons for not completing Questionnaire

A service evaluation recording the reasons for non-completion is currently underway at STH

12.2 Repeat of CG3/NG45 Audit of blood tests

As assessment of ePAQ-PO's impact on the requesting of pre-operative investigations will be made. Baseline measurements have been taken. These audits will be repeated after the implementation of ePAQ-PO. The algorithm for NG45 will need to be incorporated into ePAQ-PO V4.0

12.3 Repeat of time and motion study

STH managers agreed to further rollout of ePAQ-PO. The time and motion study should be repeated to assess its impact.

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14 Appendix

14.1 Appendix 1: Question set included in ePAQ-PO V2

ePAQ PO Version 2 included 120 questions:

Are you willing to answer some questions about your health?
Some questions may be important, even if you do not feel that the particular question is relevant. If you do not wish to answer a particular question, you can use the 'SKIP' button at the bottom of the screen to skip that question. Are you willing to look at the questions first and then decide if you wish to answer?
Are you male or female?
What is your age?
How much do you weigh?
How tall are you?
Have you ever had a general anaesthetic? (put to sleep for a surgical or dental procedure)
Have you ever had a problem with an anaesthetic?
What kind of problem was it?
What effect did these problems have on your care?
Has anyone in your family had problems with anaesthetics?
What were these problems?
Do you take any prescribed medication?
Do you take aspirin or other blood thinning drugs (eg clopidogrel)?
Do you take warfarin?
Do you take Digoxin?
Do you take Methadone?
Do you take drugs for reflux or heartburn? (indigestion)
Do you use inhalers (puffers)?
How many types do you take?
Have you taken oral steroids?
Do you take any medication for your blood pressure?
Do you take any medication for angina (chest pain or breathlessness caused by heart problems)?
Do you take any diuretics? (water tablets)
Have you ever injected drugs not prescribed by your doctor?
Do you regularly get sick when travelling in a car or bus?
Do you take HRT (Hormone Replacement Therapy)?
Do you take the contraceptive pill or have a contraceptive implant?
Are you pregnant?
Would you be able to arrange to stay with a responsible adult carer after your operation?
Do you have access to a telephone?
Please enter your telephone number (including area code) this will only be used to clarify issues to do with this questionnairre
Do you suffer from heartburn or the feeling of acid in your throat?
How often does this occur?
Do you have any neck stiffness or pain?
How much does this affect your daily activities ?
Do you have any problems opening your mouth wide?
Do you have any wobbly/loose teeth, caps or crowns (we do not need to know about fillings)

How much alcohol do you drink in 1 week? (1 unit is 1 small glass of wine, ½ pint beer or a measure of spirit)
Do you smoke
Have you ever been a smoker?
When did you quit?
Which of the following can you do comfortably?
What makes you stop?
What makes you short of breath?
Do you have any allergies?
Which of the following are you allergic to?
Have you ever experienced chest pains (angina)?
What is likely to bring on the pain?
How much does this interfere with your daily life?
Is this chest pain becoming more frequent?
Do you suffer from abnormal heart beats or are you ever aware of your own heart beat (palpitations)?
How much do these palpitations interfere with your daily life?
Have you had a coronary stent?
Have you ever had a cardiac bypass operation ? 'cabbage'
Do you have a pacemaker?
Has your pacemaker been checked in the last 12 months?
Have you ever had a stroke or a TIA (mini-stroke)?
Is this problem still under investigation?
Do you still suffer weakness or sensation changes from the stroke?
Do you suffer from black-outs / fainting?
How much do these blackouts interfere with your daily life?
Have you ever had or needed treatment for heart failure?
Are you able to lie flat on just one pillow without getting short of breath?
Do you wake up short of breath at night?
Do you have Chronic Bronchitis or Emphysema?
How much does this bronchitis interfere with your daily life?
Do you have home oxygen?
Do you have asthma?
How much does this asthma interfere with your daily life?
When you get asthma, what happens?
Have you needed to go to intensive care because of your asthma?
Have you ever taken oral steroids (e.g. Prednisolone) for your asthma?
Have you ever had Tuberculosis (TB)?
Are you receiving active treatment/medication for TB
Are you a heavy snorer?
Do you feel excessively tired during the day?
Do you have sleep apnoea?
Do you have home CPAP? (A machine to help with your breathing)
Have you ever had a heart attack?
When was your last heart attack?
Do you have, or have you ever had high blood pressure?
Is your GP happy with your blood pressure control?
Do you take any medications that end with the suffix pril or artan?
Have you ever been told that you have a heart murmur?
Have you ever had a heart valve replaced?

Are you willing to answer questions about your general health?
Some questions may be important, even if you do not feel that the particular question is relevant. If you do not wish to answer a particular question, you can use the 'SKIP' button at the bottom of the screen to skip that question. Are you willing to look at the questions first and then decide if you wish to answer?
Do you have a hiatus hernia?
Have you ever had a stomach ulcer?
Do you take NSAIDs e.g. Aspirin, Nurofen, Brufen, Volterol?
Have you ever had liver disease? (Jaundice or Hepatitis or cirrhosis)
Are you being treated or followed up for this?
Have you ever had a kidney problem?
Are you being treated or followed up for this?
Do you have diabetes?
How is it controlled?
Is your blood sugar well controlled...? What is your normal blood glucose (bm)?
Have you ever had laser treatment to your eyes?
Have you ever had any problems with your thyroid?
Are you being treated or followed up for this?
Do you take any medication for it?
Do you have epilepsy?
How much does your epilepsy interfere with your daily life?
Do you suffer with rheumatoid arthritis?
How much does your arthritis interfere with your daily life?
To your knowledge do you have HIV (Human Immunodeficiency Virus)?
Are you anaemic?
Do you or anyone in your family suffer from any of the following blood problems.
Have you ever suffered from excessive bleeding that has been difficult to control?
Would you be willing to have a blood transfusion if it were necessary?
Have you ever suffered from Deep Vein Thrombosis (DVT) or pulmonary embolus?
Are you still taking blood thinning medication for DVT or PE?

14.2 Appendix 2: Publications arising from this work

1 Patient-completed, preoperative web-based anaesthetic assessment questionnaire (electronic Personal Assessment Questionnaire PreOperative): Development and validation. Goodhart, Iain M.; Andrzejowski, John C.; Jones, Georgina L.; Berthoud, Mireille; Dennis, Andy; Mills, Gary H.; Radley, Stephen C. European Journal of Anaesthesiology: April 2017 - Volume 34 Issue 4 - p 221–228 doi: 10.1097/EJA.0000000000000545 (Paper)

2 An evaluation of factors influencing the assessment time in a nurse practitioner-led anaesthetic pre-operative assessment clinic. R. Hawes, J. Andrzejowski, I. Goodhart, G. Mills, M. Berthoud and M Wiles. Anaesthesia, Volume 71, Issue 3, 273–279, March 2016. DOI: 10.1111/anae.13340 (Paper)

3 Evaluation of the influence of ASA classification on duration of anaesthetic pre-assessment consultation time. R. Hawes, J. Andrzejowski, I. Goodhart, G. Mills and M. Berthoud. British Journal of Anaesthesia 112 (1): 181–99P (2014) (Abstract)

4 How valid is patient-reported height and weight using an interactive, computerized preoperative assessment questionnaire (ePAQ-PO)? J. C. Andrzejowski, I. M. Goodhart, M. Berthoud, S. C. Radley and R. H. Hawes. British Journal of Anaesthesia 110 (5): 860–85P (2013) (Abstract)

5 Electronic Personal Assessment Questionnaire PreOperative: patient experience and face validity of an interactive, electronic questionnaire for the preoperative assessment of patients due to undergo general anaesthesia. I. Goodhart, J. Andrzejowski, M. Berthoud, G. L. Jones, I. Wrench, N. Bennett, D. Turnbull and S. C. Radley. British Journal of Anaesthesia 109 (4): 655–68P (2012) (Abstract)

14.3 Appendix 3 QUIPP and Digital by Default

QIPP Technology Factsheet

A brief guide to Online Preoperative Screening Solutions for the NHS

Key points:

A standardised online preoperative screening system will benefit both patients and clinicians: reducing time and costs for patients as well as allowing clinicians to prioritise their time, and increasing the overall quality of care.

A study by Sheffield Teaching Hospitals has estimated saving for the Trust of £0.64M annually, based on 40,000 anaesthetics per year.

Online preoperative screening does not replace current processes; it is seen as an enhancement to preoperative assessment allowing clinicians to make better use of their time by targeting patients that need additional care.

What is Preoperative Screening?

Anaesthetic preoperative assessment is a vital element in ensuring safe surgery and anaesthesia. Online preoperative screening seeks to reduce the burden on patients and providers by:

- preventing fit and well patients from having to travel to attend the hospital;
- allowing resources to be focused more efficiently on patients who need to attend;
- reducing delays, costs and cancellations;
- enhancing the 'patient experience', quality of care, and efficiency of the service for all.

It is recommended that Trusts examine the benefits of implementing a preoperative screening tool as part of the preoperative assessment process. Typically this would include:

- A computerised pre-assessment questionnaire which is completed by patients where it is most convenient for them (e.g. at home, surgical clinic, GP surgery, or pre-op assessment clinic).
- A screening tool that provides the anaesthetic team and care-givers an accurate view of the level of risk for each patient, enabling a bespoke pre-operative care or treatment plan to be set out

Why is this important?

A standardised online pre-assessment screening system will benefit both patients and clinicians: reducing time and costs for patients as well as allowing clinicians to prioritise their time, increasing the overall quality of care.

This approach would reduce the number of visits required by fit and healthy patients (e.g. ASA 1) to preoperative clinic, avoiding unnecessary journeys, work-days missed and expenses associated with travel.

Improved patient care and efficiency for clinical staff would be realised through:

- Early triage of patients due to attend clinic (e.g. identification of ASA grade 1 patients)
- Improved audit and clinical governance for peri-operative care
- Standardisation in the pre-assessment process
- Ability to prioritise time for face-to-face assessment

Spreading Best Practice through Financial Incentives – CQUIN Prequalification

CQUIN stands for the NHS Commissioning for Quality and Innovation (CQUIN). CQUIN is a payment framework which enables commissioners to reward excellence by linking a proportion of providers' (e.g. hospitals) income to the achievement of local quality improvement goals.

The framework aims to embed quality and innovation within commissioner-provider discussions and to create a culture of continuous quality improvement with stretching goals agreed in contracts on an annual basis. The scheme has been in operation for four years, and the current total value of the CQUIN scheme is 2.5% of provider contract value. One fifth of this value (0.5 per cent of overall contract value) is to be linked to the national CQUIN goals, where these apply.

The key aim of the Commissioning for Quality and Innovation (CQUIN) framework for 2013/14 is to secure improvements in quality of services and better outcomes for patients, whilst also maintaining strong financial management.

Innovation health & wealth

Digital by default

The delivery choice for England's population