Teenage and young adult cancer in England – the patient journey and experience

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The candidate confirms that the work submitted is his/her own, except where work which has formed part of jointly authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others. Details of the publications are listed below;

Chapter 5 contains the results of a study which has since been accepted for publication in BMJ Open;

A cross-sectional survey of healthcare professionals to determine what they believe constitutes 'specialist' care for teenage and young adult cancer patients. *Rebecca J Birch, Eva JA Morris, Robert M West, Dan P Stark, Ian Lewis, Sue Morgan, Richard G Feltbower.*

All analysis and writing was undertaken by Rebecca J Birch. Other authors aided in the design of the study, planning of the analysis and proof reading of the final article.

Chapter 6 to Chapter 13 contain results which form the basis of a paper which is being written for publication. All analysis and writing is being undertaken by Rebecca J Birch. The authors named on the above paper are involved in the planning of this article.

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Abstract

Background: The Improving Outcomes Guidelines recommended treatment of teenage and young adult patients with cancer at designated principle treatment centres. Alongside age appropriate care, site specialist centres exist for several of the diagnostic groups commonly seen in these patients.

Objectives: This project aimed to produce a definition of specialist care for teenage and young adult (TYA) patients, describe the variation in care pathways nationally in England and to determine what effect the level of specialist care received has on patient outcomes.

Materials and methods: Patients aged between 15 and 24, diagnosed with cancer in England between 2001 and 2006 were identified and cancer registration and hospital episode statistics data were extracted for these cases. Patients were assigned a level of specialist care based on the proportion of their inpatient stay during treatment which was spent at a specialist centre. The variation in access to the specialist centres was assessed for each diagnostic group, as were the demographics of the patients receiving each level of specialist care. Outcomes were measured within the distinct diagnostic groups. Kaplan-Meier curves and Cox regression modelling were used to assess the impact of specialist care on survival.

Results: Variation in access to specialist care centres was seen in all diagnostic groups. The proportion of patients in each group who received specialist care also varied, with some diagnostic groups receiving very little care at specialist centres. The level and type of specialist care received was shown to affect survival in all groups. More specialist care was associated with a survival benefit in the case of leukaemia, central nervous system tumours and lymphoma, significantly so in the case of lymphoma.

Conclusions: The uptake of specialist care for teenage and young adult patients was variable across England and not all patients were seen to be receiving the care pattern associated with optimum outcomes.

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List of abbreviations

Abbreviation	Description
ALL	*Acute lymphoblastic leukaemia*
AML	*Acute myeloid leukaemia*
AYA	*Adolescent and young adult*
BCS	*Breast-conserving surgery*
BIC	*Bayesian Information Criterion*
CCLG	*Children's Cancer and Leukaemia Group*
CCSS	*Childhood Cancer Survivor Study*
CI	*Confidence interval*
CML	*Chronic myeloid leukaemia*
CNS	*Central nervous system*
DoH	*Department of Health*
DTC	*Differential thyroid carcinoma*
EMR	*Endoscopic mucosal resection*
FAP	*Familial adenomatous polyposis*
FIGO	*International Federation of Gynaecology and Obstetrics*
GI	*Gastro-intestinal*
GU	*Genito-urinary*
HES	*Hospital episode statistics*
HL	*Hodgkin's lymphoma*
HR	*Hazard ratio*
HRG	*Healthcare resource group*
IACR	*International Association of Cancer Registries*
IARC	*International Agency for Research on Cancer*
ICCC	*International Classification of Childhood Cancer*
ICD	*International Classification of Diseases*
IMD	*Indices of multiple deprivation*
IOG	*Improving Outcomes Guidelines*
JCCO	*Joint Council for Clinical Oncology*
LESG	*Late Effects Study Group*
LSOA	*Lower Layer Super Output Areas*
MAP	*MYH Associated Polyposis*
MDT	*Multi-disciplinary team*
MMS	*Mohs micrographic surgery*

MTC	*Medullary thyroid carcinoma*
NCDR	*National Cancer Data Repository*
NCIN	*National Cancer Intelligence Network*
NCRI	*National Cancer Research Institute*
NCRT	*Neoadjuvant chemoradiation therapy*
NEC	*Neuroendocrine cancer*
NHL	*Non-Hodgkin's lymphoma*
NHS	*National Health Service*
NICE	*National Centre for Health and Clinical Excellence*
NMSC	*Non-melanoma skin carcinoma*
NSPD	*National Statistics Postcode Directory*
OR	*Odds ratio*
OSGB	*Ordnance survey Great Britain*
PbR	*Payment by results*
PCT	*Primary Care Trust*
PNET	*Primitive neuroectodermal tumour*
SCT	*Stem cell transplant*
SEER	*Surveillance Epidemiology and End Results group*
SMN	*Second malignant neoplasm*
STS	*Soft tissue sarcoma*
TACE	*Trans-arterial chemoembolization*
TBI	*Total body irradiation*
TCT	*Teenage Cancer Trust*
TUR	*Trans-urethral resection*
TYA	*Teenage and young adults*
UCL	*University College London*
UK	*United Kingdom*
USA	*United States of America*
WGS	*World geodetic system*
WHO	*World Health Organisation*

Chapter 1 Introduction

Cancer is a major public health problem in the UK. Over 320,000 cases are diagnosed annually; one in three people will develop cancer during their lifetime[1]. Over 120,000 die from cancer annually[2] and it was the leading disease related cause of death in England in 2010[3]. Cancer is often perceived to predominantly be a disease of the elderly, however, despite only 0.6% of the total number of diagnoses being in the 15 to 24 age group cancer is the leading cause of non-accidental death in this population[2 4]. In comparison to many other countries cancer survival in the UK is low and there is known variation in both the quality and type of care received across the National Health Service (NHS). Improving survival and patient outcomes and eliminating inequalities has become a priority.

In an attempt to improve cancer outcomes and bring the UK in line with comparable countries the NHS and Department of Health (DoH) have implemented major service reforms. These were based upon a systematic review of the literature to form an evidence base and to determine what constitutes optimal care. This research indicated that implementing a model of specialist care would improve patient outcomes. As a result a sequence of policy documents, detailing the changes needed, were published. The Calman-Hine report[5] recommended a move from general care supported by specialists to care buy high volume, highly specialised teams. The NHS Cancer Plan[6] and the subsequent Cancer Reform Strategy[7] both focused on service changes necessary to bring about improvement in survival and both supported the emphasis placed on specialist care by the Calman-Hine report. These reports, in association with the Improving Outcomes Guidance (IOG) published by the DoH described the need for the centralisation of NHS services and specialization in cancer care. In 2005 a strategy for improving the outcomes for children and young people with cancer was released by the National Institute of Health and Clinical Excellence (NICE)[8] which recommended that specialist multi-disciplinary teams be involved throughout the care pathway, that cancer networks should strive to meet the needs of children and young people with cancer and that care should be co-ordinated across the NHS. Prior to this report there was little documentation relating specifically to this age group defining what the gold standard care pathway should be for this patient group.

The service restructuring brought about by the release of this report is now underway. It is important, therefore, to now assess the impact of centralisation and specialisation on outcomes for this age group but also to establish what proportion of patients are receiving this preferred pathway.

This project aims to quantify specialist care for teenage and young adult cancer patients. In order to do this it is vital to quantify the inequalities and inequities in relation to uptake of specialist care alongside the influence of various pathways and patterns on patient outcomes.

1.1 Study rationale

Cancer is primarily a disease of older people with 75% of all cases being diagnosed in those aged over 60. In contrast malignancy in teenagers and young adults (TYA) is less common, accounting for less than 2% of cancer diagnoses each year[9 10]. Whilst there were only 1,892 diagnoses of cancer in patients aged between 15 and 24 in the UK in 2007[9] the disease remains 2.7 times more common than in those aged less than 15[10] and is also the leading natural cause of death in this age group[11-13]. The overall incidence of cancer is increasing[14 15], a trend which is mirrored in the TYA population. However, whilst survival is improving in the cancer population as a whole[16-19] TYA survival has not improved to the same extent[4 20]. This is cause for concern.

Over the past two decades improving cancer outcomes has been a top priority for the NHS and remains as such today. Major organizational changes have been undertaken in an attempt to achieve this. The Department of Health (DoH) has issued evidence-based Improving Outcomes Guidelines (IOG) which detailed service structures and operational protocols to which cancer services ought to adhere in order to obtain optimal outcomes. This guidance focused in the most part on site-specific issues, such as lung[21] and colorectal[22] cancers. All guidelines emphasized the importance of the involvement of specialist multi-disciplinary teams and the guidance issued for TYA[8] was no exception. However in a step away from the previous guidelines the Children and Young Peoples IOG, issued in 2005 referred to the importance of both site- and age-specific specialist care, stating that;

"Care should be appropriate to a child's or young person's age and type of cancer"[8]

To define 'appropriate' is very difficult, in part due to the wide spectrum of cancers which affect TYA[23 24], also due to the acknowledged complexities of meeting the age related needs of this group[25-28] meaning that 'appropriate' care for one is not necessarily the same as that for another patient.

Little is understood about the effect of specialist care on outcomes for this group. As the evidence base is currently equivocal, it is not known whether it is age- or site-specific care or a combination of the two that leads to the best outcomes.

The Teenage Cancer Trust (TCT)[29] had eight units in place in England over the time period of this study and they aimed to fulfil the age-appropriate needs of the TYA group. These may not, however, fully encompass the site-specific needs of these patients and there is no evidence to quantify the impact of receiving one, both or neither types of specialist care. Producing a

model which can both determine what constitutes specialist care for TYA and, given the need to improve survival in this group, quantify its impact on outcomes is important and will form the main part of this project. In essence the study aims to determine whether care that is age- or site-specific in its entirety is truly 'specialist'.

As well as establishing the optimal care pathway for TYA patients it is also vital to understand the reasons for the variation in the proportion of patients receiving optimal care, including barriers to the uptake of this care, be they geographical or patient related. The effect of place of care on survival have been well studied for both older and younger patients and have been shown to influence survival, however there is a dearth of information with regards to this in TYA patients. This project will address this by quantifying the pathways and footprints of TYA patients with cancer in order to assess the national variation in the place of treatment and how this alters according to diagnosis. In an attempt to understand reasons for the variation in the proportion of patients receiving specialist care due to differing referral practices a survey of medical professionals was undertaken in which they were asked to describe factors they thought were vital for specialist care and were also asked to score each factor, from high to low importance.

A final aim is to address the paucity of information on the health service burden for TYA cancer in England. The study will examine how the level of specialist care received influences health service usage, including, number of admissions, length of stay and proportion of time spent as an inpatient. This will be an important benchmarking exercise to inform future service design.

It is acknowledged that there are issues with data quality and completeness regarding the HES and cancer registry data, many steps were undertaken in this project to address these as far as possible. These issues and methods are discussed in detail and explored extensively in the following chapters.

1.2 Summary of the aims and objectives

This project has three key aims:

I. To produce a definition of specialist care for TYA

A definition of specialist care will be produced for each diagnostic group. Patients will be assigned a 'level' of specialist care according to the proportion of their treatment period which was spent at a 'specialist' centre as opposed to any secondary or tertiary care location. The results will be described in detail in order to demonstrate the proportion of TYA patients who receive specialist care in relation to various patient demographics and diagnostic criteria, such as age, gender and tumour biology.

II. To describe variation in care pathways nationally in England.

The variation in access to such specialist care will then be quantified for each diagnostic group according to geography and patient demographics. This will help to determine the barriers that prevent individuals having access to optimal care. Variations in care pathways across England will be examined in order to quantify the known variation in place of care and to attempt to explain this. This will be performed by cancer network and proximity to an age- or site-specialist unit.

III. To determine the effect of the level of specialist care received on survival and health service usage, during treatment.

The level of care received will be used to model variations in survival, treatment patterns and other outcomes, such as cost of admissions during treatment, alongside patient factors such as level of deprivation. This will be done as an attempt to describe and quantify inequalities and inequities in the treatment of TYA cancer patients in order to determine how much of an effect the optimal treatment pathway has on patient outcomes.

The patient outcomes to be assessed will include survival, treatment and health service usage during the treatment period. These will be modelled alongside other patient and tumour characteristics such as age and diagnostic group.

1.3 Main contribution of this work

This work aims to address the current gap in the literature surrounding specialist care for teenage and young adult patients. Whilst it is acknowledged that specialist care is associated with better outcomes for older adults and children[30-35], little fix reference is known about the impact on outcomes for TYA patients. Previous studies have sought to qualify where TYA patients are treated[36-38], to define specialist care for this group, including both age- and site-specific specialist inpatient care[37 39-41], and to quantify its influence on outcomes[42 43]. However none have examined all three together and few examine such a broad range of diagnostic groups. This will be the first to attempt to identify factors which influence outcomes in all the diagnostic groups most commonly seen in this age range and will also be the first to describe the factors which affect the likelihood of attendance at a pre-defined specialist centre.

1.4 Report outline

The evidence base for this study is discussed in Chapter Two, detailing what is already known about specialist care in teenage and young adult cancer patients and describing the paucity of information for certain areas. The methodologies used are detailed in Chapter Three and describe both the statistical and descriptive methods used. Chapter 4 describes the

characteristics of the study population. The details of a survey examining attitudes towards specialist care are described in Chapter 5, and Chapter 6 to Chapter 13 discuss the findings of the study. These results are then described in the context of current cancer policy and practice in Chapter 14 and Chapter 15.

Chapter 2 Literature review and evidence base

2.1 Introduction

The majority of cancers occur in patients over the age of 60, fewer than 2% of all cancers are diagnosed in patients between the ages of 15 and 24[9]. Despite the rarity of cancer among 15-24 year olds, when compared to older age ranges cancer is the leading natural cause of death in the aforementioned group [44-46].

Cancers in TYA occur at different frequencies to those of older adults and children, additionally survival for this group has not shown the same degree of improvement as others. This, along with the proportion of deaths in TYA caused by cancer and the unique characteristics and needs of this group means that they have different requirements and so do not fit easily in with any other group. This has been a relatively recent realisation and so there are gaps in the evidence base regarding the treatment, outcomes and needs of this patient group. Before attempting to address the aims identified in the previous chapter it is firstly vital to assess the current evidence base regarding specialist care for teenage and young adult patients and to identify areas where little or no research has been undertaken and any remaining unanswered questions.

2.2 Why are teenage and young adult patients a distinct group?

The definition of adolescence or teenage in the terms of cancer differs from the legal and social definition [47]. The current definition of TYA in the UK varies slightly between study groups however the most commonly used is that of patients aged between 15 and 24 years. The National Cancer Action Team and the Improving Outcomes for Children and Young People with Cancer guidelines both refer to TYAs as being between ages 16 and 24, but both state this can be expanded to include patients as young as 13 [48]. The National Cancer Research Institute (NCRI) also defines TYA as being aged 13 to 24 years [49]. In contrast the National Cancer Institute in America defines their equivalent of TYAs, AYAs (adolescents and young adults), as being aged 15 to 39 years [50]. The World Health Organisation defines youth as being between the ages of 15 and 24 and this definition of teenagers and young adults therefore falls in the middle of the definition used by US and Australian cancer study groups and mirrors that commonly used in the UK. The National Registry of Childhood Tumours (NCRT) collects data on patients up to their 15th birthday, this means that 15 acts as an ideal lower age range for TYA's in England as patients aged above 15 are not covered by the childhood research groups. The

upper age limit of 24 also prevents overlapping research as patients aged greater than this tend to be included in adult studies. The age ranges may vary from study to study depending on the type of malignancy being examined and the country of origin. However the age range of 15 – 24 years appears to define TYAs without overlapping with paediatric or adult studies. This age group has also seen the poorest improvement in both the long and short term when compared to other ages; this also makes this age range appropriate when defining a cohort with the greatest need [44 51-63].

Teenagers and young adults fall into a gap between paediatric oncology and adult oncology; this causes problems with consistency of treatment as they may be treated in either unit. There are several factors which have been stated that make TYAs a distinct treatment group. Those which are commonly mentioned are the differing psychosocial needs of this age group, the delays in diagnosis and the long term effects of both the cancer and the treatment provided [50 64]. The host and disease biology of cancer in teenagers and young adults differs from that seen in both children and adults [64-67]. Teenagers often undergo growth spurts; these have been associated with more virulent disease than that seen in adults.

The spectrum of cancers which affect teenagers and young adults varies greatly from those seen in other age groups. Common cancers of teenagers and young adults include; Hodgkin's lymphoma, germ cell tumours, acute leukaemia, CNS tumours, soft tissue sarcomas, non-Hodgkin's lymphoma, thyroid carcinoma, malignant melanoma and bone sarcomas [64 68]. Common tumours of childhood such as embryonal malignancies are rarely seen in teenagers and young adults, carcinomas commonly seen in later adulthood are rarely seen in TYA patients.

The widely varying spectrum of cancers affecting this age group and their unusual position in terms of age focused services means that specialist care, encompassing all aspects of care, age and cancer site specific, does not exist for these patients in the same way that it does for both older and younger patients. As such specialist care is difficult to define for TYA cancer patients.

The unique set of characteristics of TYA cancer patients often means that they exist in a gap in cancer services, with diagnostic and treatment decisions varying from patient to patient. This project aims to address the national variation in referrals and treatment and assess the influence of specialist care on patient outcomes in this age group.

This combination of factors means that cancer in TYA patients poses a unique problem for policy makers and those involved in their treatment. They cannot easily fit into services designed for use by others and it is thought that attempts to do so result in suboptimal outcomes[11 12 39 69].

2.3 The epidemiology of cancer in teenagers and young adults

Common cancers of TYA include; Hodgkin's lymphoma, germ cell tumours, acute leukaemia, CNS tumours, soft tissue sarcomas, non-Hodgkin's lymphoma, thyroid carcinoma, malignant melanoma and bone sarcomas [44-46 50 70-77]. Some of the most common malignancies in subjects aged 15 to 19 years are leukaemia and bone tumours, in comparison to patients aged 20 to 24 years where the most common are carcinomas, central nervous system tumours and melanoma [77]. Common tumours of childhood such as embryonal malignancies are rarely seen in teenagers and young adults [78].

Cancers diagnosed in TYA but also seen in other age groups often present with different tumour characteristics in TYA than in children and older adults. For example gastric and colorectal cancers are infrequently seen in TYA; when they do occur the tumours are often of a different morphological type than those seen in older patients and are often more aggressive [79 80]. These differences will also have implications for the treatment of malignancies in patients aged 15 to 24 years.

2.4 Classification of cancer in teenagers and young adults

There are several schemes to classify childhood, young adult and adolescent cancers. These are different from the classification schemes used to describe cancers of adulthood as there is a greater morphological variation in younger patients which is not fully described by the ICD-10 coding system which refers mainly to the topography of a tumour. The International Classification of Childhood Cancer scheme (ICCC), published in 1996, is based on histological characteristics and was developed specifically for childhood cancers [81]. However within this classification scheme a high percentage of teenage and young adult cancers fall within the other and unspecified carcinoma category, 5.6% of 15-19 year olds and 13.6% of 20-24 year olds were shown to fall into the other and unspecified carcinoma group in one study[76]. Another classification scheme is the Histological Groups for Comparative Studies which was developed by the International Agency for Research on Cancer (IARC) in 1998. This scheme has 15 main groups [76]. The classification scheme by Jill Birch et al [77] (see Appendix 1) is specifically designed for use in the classification of teenagers and young adults. It consists of ten main groups and several subgroups and allows malignancies to be classified more accurately by morphological type and topography where relevant [77]. The advantage of this scheme is the detailed groupings of malignancies and the division by morphological type rather than cancer site as the morphological type of a cancer in TYA's has greater influence than in adults.

There is some disagreement as to whether benign tumours ought to be included in the analysis of TYA malignancies. In the Birch classification scheme benign central nervous system tumours are included due to their symptomology and associated mortality.

2.5 Incidence of cancer in teenagers and young adults

The spectrum of cancers in TYA patients are different from those seen in younger and older patients (Figure 1 & Figure 2). The most common cancers differ between male and female TYA patients and in both cases these differ from those seen in other age groups. Common diagnoses include leukaemia, lymphomas, and brain and bone tumours[82], far fewer epithelial malignancies are seen in this age group compared to older adults.

Figure 1: The 5 most commonly diagnosed cancers in males, by age, UK, 2008-2010[9]

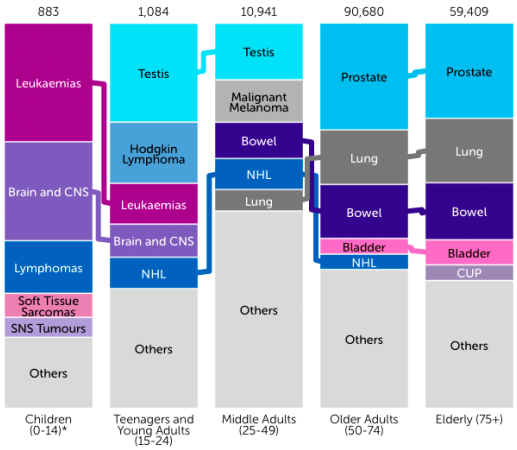
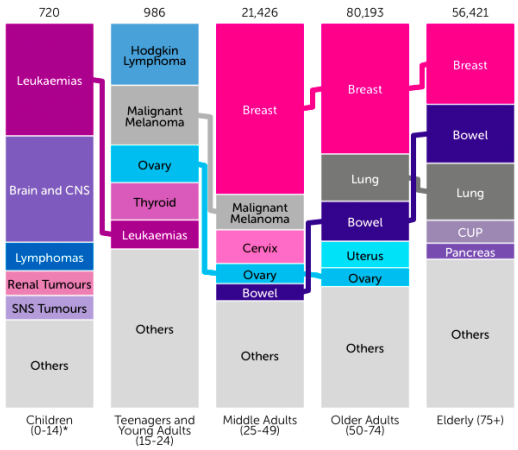


Figure 2: The 5 most commonly diagnosed cancers in females, by age, UK, 2008-2010[9]



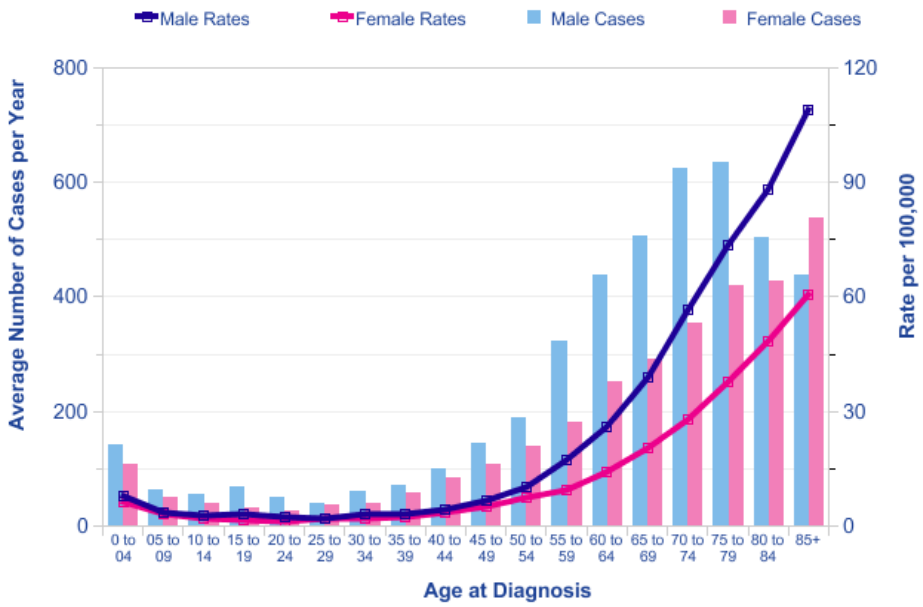
Source: Cancer Research UK (CRUK): http://www.cancerresearchuk.org/cancerinfo/cancerstats/incidence/age/

It is important to understand that it is not only the incidence by diagnostic group which varies by age but also the morphology within these groups[77]. Differing morphologies have differing prognoses and treatment pathways meaning that this is an important factor to quantify. This is particularly marked in haematological malignancies, the incidence of acute lymphoid leukaemia (ALL) decreases with age whereas chronic myeloid leukaemia (CML) increases. The two diseases have very different treatment profiles and outcomes[9].

2.5.1 Incidence by diagnostic group

2.5.1.1 Leukaemia

Figure 3: Leukaemia (C91-95), average number of new cases per year and age-specific incidence rates, UK, 2006-2008[83]



Source: Cancer Research UK (CRUK), 2012

Leukaemia is amongst the five most common cancers diagnosed in both male and female patients aged between 15 and 24 (Figure 1 & Figure 2). Despite this the peak of incidence for leukaemia occurs at 70 to 74 years of age for males and 85 years plus for female patients. Teenagers and young adults fall into a group with the lowest incidence rate, males have a greater incidence than females. The incidence of leukaemia in patients aged less than 5 years is double that of patients aged between 15 and 24 years (Figure 3). However this data does not take into account the variation in incidence of different morphological types of leukaemia which have a high incidence in younger patients. The low overall incidence of leukaemia in teenagers and young adults compared to older and younger patients does not account for the relatively high incidence of leukaemia compared to other malignancies within the age group.

2.5.1.2 Lymphoma

Figure 4: Non-Hodgkin's Lymphoma (C82-C85 and C96), average number of new cases per year and age-specific incidence rates, UK, 2007-2009[84]

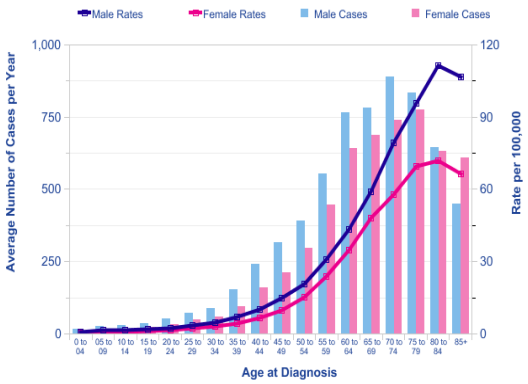
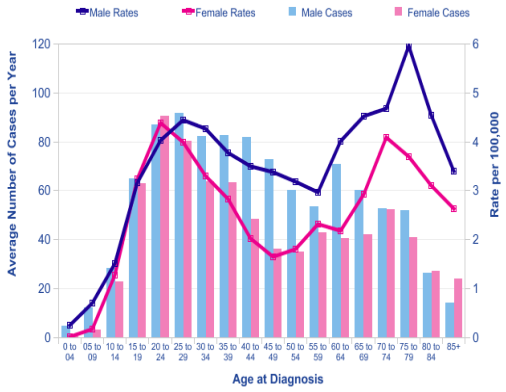


Figure 5: Hodgkin's Lymphoma (C81), average number of new cases per year and age-specific incidence rates, UK, 2008[85]



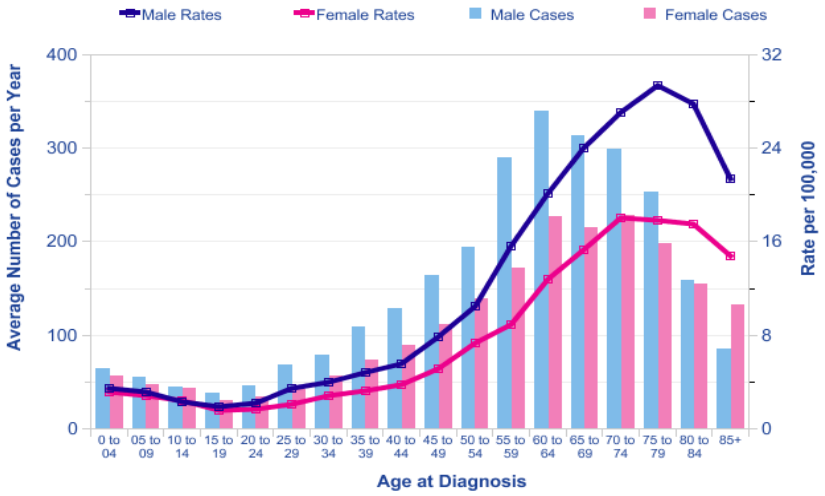
Source: Cancer Research UK (CRUK), 2012

Non-Hodgkin's lymphoma is one of the five most common malignancies diagnosed in male TYA patients (Figure 1), Hodgkin's lymphoma is one of the most common for both male and female TYA patients (Figure 1 & Figure 2). Hodgkin's lymphoma is unusual in that it has a bimodal peak of incidence, one of which occurs in early adulthood (Figure 5). Incidence of Hodgkin's lymphoma is higher in female patients aged 20 to 24 than male patients of the same age, this is the opposite of the trend for the remaining age groups, both older and younger. For both genders there is a peak in incidence of Hodgkin's lymphoma at approximately 25 years of age.

The greatest number of cases of Hodgkin's lymphoma are diagnosed within the TYA age group (Figure 5), for non-Hodgkin's lymphoma this occurs in patients aged between 70 and 74 (Figure 4).

2.5.1.3 *Brain and central nervous system tumours*

Figure 6: Malignant brain and other CNS tumours (C70-C72), average Number of New Cases per Year and Age-Specific Incidence Rates per 100,000 Population, UK, 2006-2008[86]



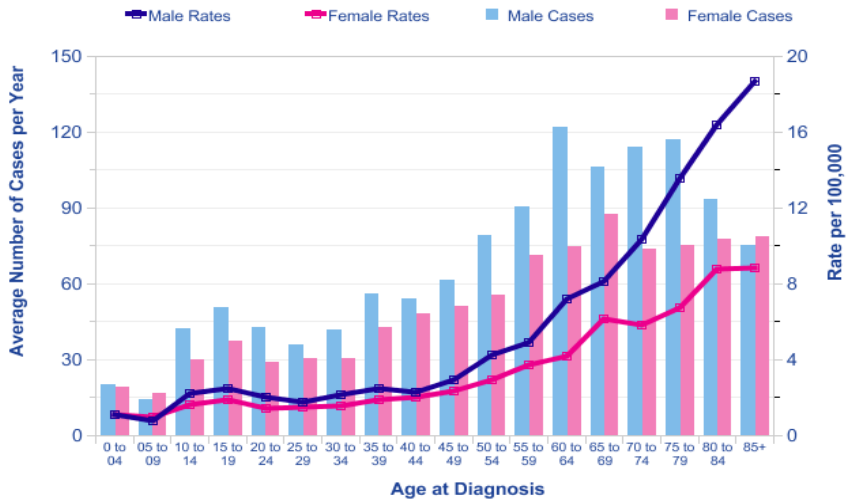
Source: Cancer Research UK (CRUK), 2012

Brain and central nervous system tumours have a peak in incidence later in life for both sexes, once again incidence is higher in males than females with the exception of a slightly higher incidence in females aged over 85 years. The number of new cases in male patients between 15 and 24 years is very similar (approximately 40 cases in 2005), however the number of cases in female patients almost doubles between patients aged 15 to 19 years and those aged 20 to 24 years. Although the incidence of brain and CNS tumours in teenagers and young adults is lower than any other age group the incidence of brain and central nervous system tumours is high when compared to other malignancies within the 15-24 age group (Figure 6).

Brain tumours are unusual in that the morphological types have very different outcomes. The most common morphological types in TYA are astrocytoma, gliomas and medulloblastoma and other primary neurorectodermal tumours (PNET) tumours[10 75 82 87]. A study by Barr found a common increase in gliomas with age and a decrease in medulloblastoma and other PNET with increasing age[88].

2.5.1.4 *Osseous and chondromatous neoplasms*

Figure 7: Bone and connective tissue cancer (C40-41, C47 and C49), Average Number of New Cases per Year and Age-Specific Incidence Rates per 100,000 Population, UK, 2006-2008[89]



Source: Cancer Research UK (CRUK), 2012

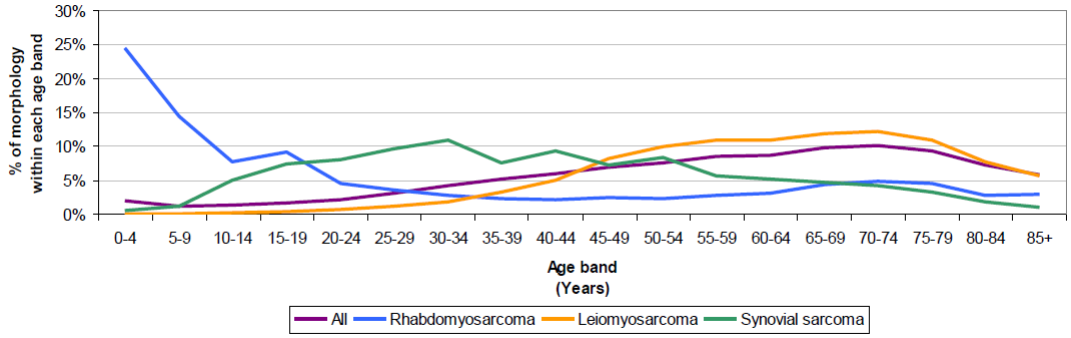
The incidence of bone and connective tissue cancers does not show the same age related pattern as for other cancers. There is a higher average incidence in male patients than female patients, and in other diagnostic groups young adults do not have the lowest incidence (Figure 7). The number of new cases between 2006 and 2008 in patients aged 15 to 24 years was twice that of patients less than 15 years of age.

Bone tumours account for approximately 3% of the cancers of childhood and 4% of malignancies in teenagers and young adults[90-93]. The similarity between the incidence of bone tumours in children, teenagers and young adults does not take into account the differing morphologies between the age groups.

2.5.1.5 *Soft tissue sarcoma*

In the population as a whole soft tissue sarcomas are rare, accounting for approximately 1% of all cancer diagnoses annually[94]. Despite this soft tissue sarcomas are amongst the most common malignancies diagnosed in TYA patients[75 82 95]. Different morphological types occur at different rates within the population (Figure 8) and occur at different sites within the body[94]. Each requires different treatment and is associated with different outcomes. This combination of rarity and wide range of morphologies and cancer sites means that few centres treat large numbers of STS patients, even fewer treat significant volumes of TYA STS patients.

Figure 8: Percentage of sarcomas and selected morphologies by age, England, 1990-2007[94]



2.5.1.6 Germ cell and trophoblastic neoplasms

Germ cell and trophoblastic tumours are most commonly found in the gonads of both male and female patients. Over 95% of all testicular tumours are germ cell tumours[96], in contrast fewer than 10% of ovarian tumours are of germ cell origin. However the majority of ovarian tumours diagnosed in pre-menopausal women are germ cell tumours[97].

Most germ cell tumours are found in the male gonads (testes), a smaller proportion are found in the ovaries and a smaller proportion still are found elsewhere in the body. The most common site for these is the central nervous system[98].

The incidence of both gonadal and non-gonadal germ cell tumours increases with age. Germ cell and trophoblastic neoplasms of the gonads have the second highest incidence of the malignancies commonly found in patients aged between 20 and 24 years, surpassed only by Hodgkin's lymphoma.

Figure 9 and Figure 10 demonstrate the age-incidence peaks for all ovarian and germ cell tumours, both epithelial and non-epithelial. The vast majority of tumours diagnosed in the age range of interest will be of germ cell origin, therefore these figures are representative of the incidence of germ cell tumours in TYA.

Figure 9: Ovarian Cancer (C56-C57), Average Number of New Cases per Year and Age-Specific Incidence Rates, UK, 2006-2008[97]

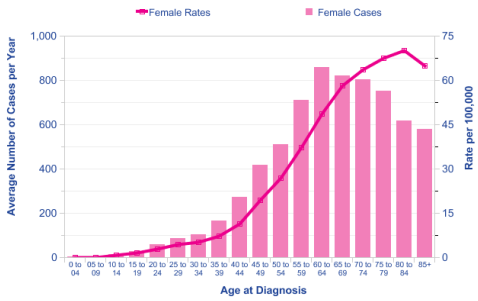
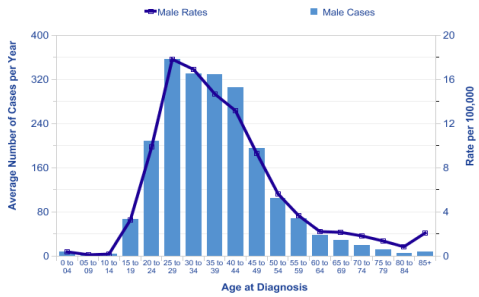


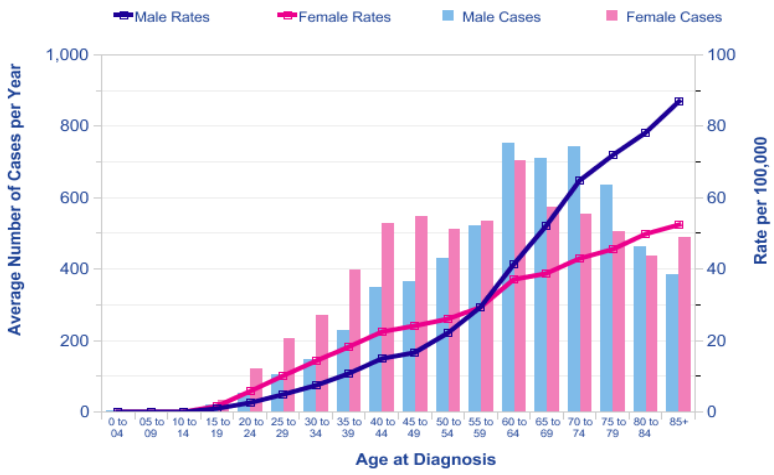
Figure 10: Testicular Cancer (C62), Average Number of New Cases per Year and Age-Specific Incidence Rates, UK, 2006-2008[96]



Source: Cancer Research UK (CRUK), 2012

2.5.1.7 Melanoma and skin carcinoma

Figure 11: Malignant Melanoma (C43), Average Number of New Cases per Year and Age-Specific Incidence Rates, UK, 2008-2010[99]



Source: Cancer Research UK (CRUK), 2012

The incidence of melanoma peaks in later life (Figure 11) but is one of the most common malignancies diagnosed in females between the ages of 15 and 24 (Figure 2). Non-melanoma skin cancer occurs more frequently than malignant melanoma but the quality of registration is known to be variable[100].

2.5.1.8 Carcinomas

Thyroid cancer has the highest incidence of all carcinomas in patients aged between 15 and 19[10 77 100]. Carcinoma of the genito-urinary tract (GU tract) has the highest incidence in patients aged between 20 and 24 years[77].

The incidence of carcinoma increases rapidly with increasing age. Carcinomas account for 56% of malignancies diagnosed in patients aged over 24 year in comparison to 34% and 12% in teenagers and young adults and children respectively[1].

Carcinomas of the genitourinary tract are the most commonly diagnosed in TYA (excluding skin carcinoma), one study showed them as accounting for 6.4% of all diagnoses in this age group[77]. The second most commonly diagnosed carcinoma was that of the thyroid (3.2%), followed by carcinoma of the gastrointestinal tract (2.7%)[77]. Carcinomas are predominantly found in older adults and those diagnosed in younger patients tend to have poorer outcomes than their older counterparts[101 102]. The wide range of carcinomas diagnosed in small numbers of TYA patients result in few centres seeing many TYA carcinoma patients meaning that few truly specialist centres exist for this group.

2.5.2 Temporal changes in incidence

As with all cancers there has been a change in incidence over time of the malignancies which commonly occur in teenagers and young adults. This change is not limited to a single country or geographical region but is seen globally. The incidence of invasive cancer in both the United States and the United Kingdom in 15 to 19 year olds increased by approximately 0.9% per year [103]. Within this the incidence of non-Hodgkin's lymphoma and testicular carcinoma had the greatest increase, at almost 2% per year [103]. Data from the Southern Netherlands showed an increase of 3% per year between 1973 and 1999 for haematological malignancies in patients aged up to 24 years of age [104]. A study from data collected in the North Netherlands showed an annual percentage increase of 2.15% [105].

2.5.3 Geographical variation in incidence

Studies into geographical variation in incidence have shown marked differences at local, national and international level. Data from England showed rates of leukaemia to be highest in London and the south east, Hodgkin's and non-Hodgkin's lymphoma to be highest in the south and bone and soft tissue sarcomas to have the highest incidence in the London and the lowest in the North West[23 74]. Germ cell tumours also had the highest incidence in the south west.

A study describing the incidence of cancer in TYA throughout Europe showed the overall incidence between 1988 and 1997 to be 139 per million. This varied between countries from 116 per million to 173 per million [56]. Some of this variation can be attributed to environmental

influences. The incidence also varied greatly by region, from 169 per million in the East of Europe to 210 per million in the North of Europe for patients aged 15 to 19 years of age [106].

The incidence of specific cancer type; also varies greatly by geographical region, an example is the incidence of lymphoid leukaemia which was shown to have the highest incidence in the UK and the South of Europe, whilst the lowest incidence was seen in Eastern Europe. Variation was also seen in bone tumours, NHL, CNS and germ cell tumours[71 106].

2.5.4 Gender and incidence

Rates of cancers are typically higher in males than females for all ages. On average males are 10%- 25% more likely to be diagnosed with cancer than females in their teenage years, there is a transition to a female predominance in adult years [44].

Rates for ALL and non-Hodgkin's lymphoma are significantly higher in males than females but rates of Hodgkin's lymphoma are similar for both sexes [77 82]. Central nervous system tumours have been shown to have higher incidence rates in male patients aged 20 to 24 years than those aged 15 to 19 years, but not for females [77 103].

The incidence of germ cell tumours in males increases with age and is most frequently seen in patients aged between 20 and 24 years. The most common subtype is non-seminomatous testicular cancer [107].

2.5.5 Ethnicity and incidence

The majority of studies focusing on ethnicity and the incidence of cancer in teenagers and young adults have been performed using American data due to the improved level of reporting of ethnicity in the United States compared to that of the UK and other countries.

In the United States the highest reported incidences of cancer in people aged 15 to 35 years of age are found in the white, non-Hispanic population, this is approximately double that of the American Indians and Native Alaskans [73]. It has also been shown that the incidence of common TYA malignancies is higher in Caucasian than in black persons of the same age [103].

Hodgkin's lymphoma has been shown to be more common amongst white, non-Hispanics in the United States, as this tends to be a more affluent group, there is also a potential link with deprivation and the incidence of Hodgkin's lymphoma [108]. Testicular cancers have also been shown to have an increased incidence in whites compared to blacks in the United States, as have tumours of the bone and joints[108]. Nasopharyngeal carcinoma is very common in teenagers and young adults in the Far East, however this has been linked to environmental and behavioural factors, such as smoking, nitrosamines and the Epstein-Barr virus, rather than ethnicity per se [108].

Studies have been performed using data from the UK to determine what, if any, effect ethnicity has on cancer incidence. In the UK, children of South Asian origin have an increased incidence of lymphoma and a lower incidence of Wilm's tumour and soft tissue sarcoma when compared to white children.

2.5.6 Deprivation and incidence

In studies into common cancers of adulthood deprivation has been shown to have a significant effect not only on the outcome but also on the incidence of cancer. The relationship of higher incidence rates seen in the most deprived areas, has also been shown to apply to some teenage and young adult cancers. Several studies have shown chronic myeloid leukaemia to have a higher incidence in the most deprived areas[74], however this trend does not apply to all leukaemia, there has been shown to be little association between level of deprivation and incidence of acute lymphoblastic leukaemia or acute myeloid leukaemia [74]. The level of deprivation can be ascertained using several methods, two of the most common being the Indices of Multiple Deprivation (IMD)[109] and the Townsend Material Deprivation Score[110].

The Oxford Indices of Multiple Deprivation is calculated using several components combined. The seven components used are; income, employment, health and disability, education, skills and training, barriers to housing and social services, living environment and crime. Each geographical area is then given a score which is weighted to produce an index value. In contrast the Townsend score is derived solely from census data.

Hodgkin's lymphoma does not follow the generally accepted rule of adult cancers that increasing deprivation leads to increased incidence, in fact Hodgkin's lymphoma has shown a marked decrease in incidence with increasing deprivation [74]. The incidence of central nervous system tumours (CNS), germ cell tumours and melanoma also follow the same pattern as Hodgkin's lymphoma [74]. There has been shown to be no link between deprivation and incidence in bone tumours and STS [74].

2.6 What is specialist care for teenage and young adult cancer patients and how does it influence outcomes?

The Calman Hine report identified a need for specialist units in every regional centre to provide access to a teenage unit for every patient between 13 and 25 years of age [5 111]. The need for change in order to improve outcomes for teenage and young adult cancer patients was recognised and led to the introduction of the Improving Outcomes Guidelines for Children and Young People. This report built on areas of concern which had been identified in previous

research. Through the review of the literature a need for increased specialisation and service reform was identified[8].

There is a compelling amount of research to suggest that teenagers and young adults have a significantly better outcome when treated using age appropriate protocols, either paediatric or TYA[46 112 113]. Those treated on a paediatric protocol are also more likely to be enrolled onto a clinical trial than those treated using an adult protocol 46 [113]. There are many possible reasons for this difference in outcome. One is the differing morphology of malignancies seen in patients aged between 15 and 24; an example is the increasing incidence of factors associated with poor outcomes in ALL. Children tend to have prognostically favourable subtypes of ALL, whereas TYA exhibit greater occurrence of pseudodiploidy and the Philadelphia chromosome[65], both are linked to poor prognosis. The MLL gene rearrangement is more common in adults than children; it is associated with hyperleucocytosis and CD 10 negative B-precursor phenotype and a poor prognosis [65].

As well as the differing clinical needs, their psychological and social requirements also need to be taken into account[25 39 114]. The effect of transition into adulthood is important in terms of the loss of recently gained independence and the impact of a life threatening illness[25]. TYA therefore not only need specialist medical treatment but also specialist support to facilitate their re-integration into society.

Specialist care is defined for adult cancers as treatment received in a cancer centre, provided by a consultant specialising in the cancer in question, with surgery performed at a high volume centre by a surgeon who performs a large number of the same operation annually[115-119]. The impact of hospital volume on operative mortality for cancer surgery showed that hospitals which treated a low number of cases requiring complex surgery had a higher mortality than those treating a larger number of cases[115]. Several studies, which used patient volume to represent specialisation, suggested that specialist cancer care significantly improved outcomes[115 117 119]. Another defining factor of specialist care for adults is treatment by a multidisciplinary team (MDT). Studies have directly linked increasing workload of an MDT to improved quality of clinical care and greatly improved patient outcomes[116 118].

In the treatment of childhood cancer specialist care is defined more by age appropriate care than by cancer site [120]. The care of teenagers and young adults often falls between the younger children and older adults and should include aspects of both populations.

One of the major areas discussed in the IOG was the introduction of principal treatment centres (PTC) which would act as tertiary treatment centres for TYA cancer patients. The implementation of these guidelines began in 2006, towards the end of the time period that

this study covers. These guidelines recommended the involvement of MDTs in all aspects of care, and referral to a high volume treatment centre. As previously described both of these have been associated with improved patient outcomes for older adults. The IOG for Children and Young People with cancer produced by NICE [121] made several recommendations for the treatment of TYA with cancer. The recommendations focus on the provision of the best quality care as close to the patients home as possible, treatment by a TYA MDT; treatment based on agreed protocols, care appropriate to both the patient's age and type of cancer and the opportunity to participate in clinical trials.

NICE state in their Improving Outcomes in Children and Young People with Cancer guidelines that:

" there is a need for all young people with cancer to benefit from the expertise of both site-specific multidisciplinary teams (MDTs) and the new Teenage/Young Adult MDTs and have unhindered access to an age-appropriate care environment and psychosocial support is an essential aspect of the NICE Improving Outcomes for Children and Young People with Cancer Guidance" [8]

This describes the need to incorporate aspects of specialisation from both adult and paediatric oncology treatment guidelines. Several factors which could influence the definition of specialization in teenagers and young adults are listed below;

- Consultant/ hospital volume.
- Age appropriate care.
- Treatment by a consultant with a cancer specific interest (e.g. STS)
- Age appropriate psychological and social support.
- Access to clinical trials.

The difficulty in defining specialization is in establishing the importance attached to each of these factors in terms of their effect on clinical outcomes.

Principle treatment centres for TYA patients consist for the most part of Teenage Cancer Trust (TCT) units. The Teenage Cancer Trust (TCT) was founded in order to provide care specifically tailored to meet the needs of TYA with cancer. By the end of 2012 in the UK there were 20 TCT units offering inpatient beds and outpatient facilities [122]. The current lack of units nationally means that two 16 year old patients referred to the same cancer centre with the same disease may be seen by different teams altogether, one by a paediatric team and one by an adult team. This reduces the consistency of care and may lead to suboptimal treatment and unfavourable outcomes [46 114].

There is currently a programme of expansion underway in the UK with the aim of providing enough beds for all patients between 13 and 25 with cancer. A study using data from the Thames cancer registry revealed that the majority of 10- 14 year old patients were referred to a specialist unit away from their cancer network of residence [36]. However patients aged 15-24 were much more likely to remain in their network of residence and not be referred to a specialist unit. Overall 23% of patients aged 15-19 were seen in a teenage cancer unit [36]. There are 20 designated Children's Cancer Study Group Centres in the UK, in contrast there are currently 8 TCT units in the UK. It has been shown in the Southeast of England that there is an absence of a referral pattern despite there being a teenage cancer unit in the area [36] . This means that teenagers and young adults are much less likely to receive treatment in an age appropriate centre than any other age group.

Teenagers and young adults fall between paediatric and adult oncology and so their care needs to encompass aspects of specialisation from each. The National Institute for Clinical Excellence (NICE) states that teenagers and young adults should be treated in an age appropriate but also a site-specific environment [36].

The Calman-Hine report emphasised the need for specialisation in the treatment of cancer[5]. Site specific guidelines for the treatment of several of the cancers commonly seen in TYA patients have been introduced by NICE. All of the site specific guidelines describe the service requirements for the treatment of each cancer and the minimum numbers of patients to be treated by each unit. Due to the rarity of sarcoma, both bone and soft tissue, and brain and CNS tumours services are centralised throughout the UK with a small number of units treating all patients in order to meet the minimum number of patients required[123].

It will be possible to use this study to produce a baseline against which the changes in service delivery post implementation can be measured. Specialist treatment centres existed before the implementation of the IOG and the effect of treatment at a specialist unit can still be measured.

2.7 Where are teenage and young adults patients treated?

2.7.1 Cancer units

A cancer unit is defined in the Calman-Hine report as a district hospital able to provide a full range of supportive services and to see a sufficient volume of the more common cancers to be able to provide surgical sub-specialisation for the treatment of these sites (breast, colorectal etc.)[5]. Each unit ought to have a lead clinician heading and co-ordinating the entire cancer

service, inclusive of chemotherapy. Radiotherapy is usually provided solely at cancer centres, as is complex chemotherapy and bone marrow transplantation.

These units are often local and as such are attractive to patients not wanting to travel significant distances from home, a factor which is often important in the decision making process for TYA patients.

2.7.2 Cancer centres

A cancer centre provides both secondary and tertiary care to cancer patients and will treat both common and less common cancers. The additional services (radiotherapy, specialised surgery and complex chemotherapy) provided by a cancer centre are in place to support cancer units. Due to the large number of cases treated cancer centres provide a high level of sub-specialisation.

For the majority of patients their local hospital is a cancer unit rather than a cancer centre, meaning that travel times to cancer centres are often greater than to the closest unit. However the high level of specialisation and availability of a wide range of treatments may encourage more patients to attend cancer centres.

Many patients attend more than one hospital during the course of their treatment with complex procedures, such as radiotherapy or specialist surgery being performed at a centre and other treatments being administered at a unit. This is an important care pathway to understand as this may influence patient outcomes in a different way to receiving all care in one location.

2.7.2.1 Cancer site specialist centres

Cancer site specialist centres are based within cancer centres and often act as a tertiary or extra regional centre for the treatment of some of the rarer cancer types, or those requiring highly specialised treatment. Specialist centres exist for the treatment of bone tumours, STS and brain tumours amongst others[123 124].

2.7.3 Teenage and young adult cancer centres

All teenage and young adult cancer units in England are located within a cancer centre, thus providing access to a high level of cancer site sub-specialisation and age appropriate treatment. However not all cancer centres have a teenage and young adult unit. This means that, as with cancer centres, teenage cancer units are often extra-regional[29].

There are currently 20 teenage cancer trust units in the UK, during the time period of this study there were between 4 and 7 fully functioning units[29].

One of the major areas discussed in the IOG was the introduction of principal treatment centres (PTC) which would act as tertiary treatment centres for TYA cancer patients. The implementation of these guidelines began in 2006, towards the end of the time period that this study covers. This study will be used to produce a baseline against which the extent of the implementation of the guidelines and the impact of these changes can be measured. Specialist treatment centres existed before the implementation of the IOG and the effect of treatment at a specialist unit can still be measured.

The Teenage Cancer Trust (TCT) was founded in order to provide care specifically tailored to meet the needs of teenagers and young adults with a malignant disease. There are currently eight TCT units in the UK, as of 2008, with the ninth under construction. The Calman Hine report identified a need for specialist units in every regional centre to provide access to a teenage unit for every patient between 13 and 25 years of age [111]. Countries such as Australia, Canada and France have begun work on establishing specialist units. There is currently a programme of expansion underway in the UK with the aim of providing enough beds for all patients between 13 and 25 with cancer.

As teenagers and young adults fall between paediatric and adult oncology their care needs to encompass aspects of specialisation from each. The National Institute for Clinical Excellence (NICE) states that teenagers and young adults should be treated in an age appropriate but also a site-specific environment [36].

2.8 Factors affecting access to and use of specialist care

2.8.1 Travel times and access to specialist centres

A study using data from the Thames Cancer Registry revealed that the majority of 10- 14 year old patients were referred to a specialist unit from their cancer network of residence [36]. However patients aged 15-24 were much more likely to remain in their network of residence and not be referred to a specialist unit, 23% of patients aged 15-19 were seen in a teenage cancer unit [36]. In the USA 90% of children under 15 years of age are seen in units sponsored by the Children's Oncology Group, in contrast only 24% of 15- 19 year olds are seen in specialist age appropriate units [125].There are 20 designated Children's Cancer Study Group Centres in the UK, in contrast there are currently 8 TCT units in the UK. It has been shown in the Southeast of England that there is an absence of a referral pattern despite there being a teenage cancer unit in the area [36] . This means that teenagers and young adults are much less likely to receive treatment in an age appropriate centre than any other age group.

Following the Improving Outcomes Guidelines and the Calman-Hine report cancer care in the UK has been reorganised into a small number of specialist centres, with a focus on a centralisation of specialist expertise. For less common cancers, such as those diagnosed in teenagers and young adults this resulted in a widespread distribution of relatively few TYA focused units. TCT units are located at cancer centres rather than cancer units (found at general hospitals) and due to the centralisation of tertiary care, patients often have to travel outside their local area for treatment. A study by CLIC Sargent discovered that 77% of childhood cancer patients (aged 0-18 at diagnosis) did not live in a city with a PTC leading to the average travel time for treatment being 55 minutes each way (average distance of 60 miles) [126]. There is a slight overlap in age groups between the CLIC Sargent study group and that of this study, suggesting that the results may mirror each other.

Patients aged under 16 at diagnosis are automatically referred to a hospital with a TCT unit, patients aged 16 and above are given the choice as to whether to travel to the nearest TCT unit or visit their local hospital[8].

Alongside the centralisation of TYA services certain diagnoses which are more common in this age group require treatment at site specialist centres, such as bone tumours. There are currently five bone tumour specialist centres in the UK, all of which are located in England[123].

The dispersal of TYA units alongside that of the tertiary care centres for specific diagnoses means that TYA patients who choose to be treated at a cancer centre may travel significant distances to receive their cancer care.

Centralisation of services leads to increased provider volume and specialisation at specified centres, high volume centres have been shown to have improved post-operative mortality when compared to low and medium volume centres for complex surgical cases [127]. Patients seen at high volume centres have been shown to be more likely to undergo a surgical tumour resection for specified tumour sites [128], this was also associated with increased travel time for the same subset of patients. There is some disagreement about whether it is the provider volume or the degree of specialisation of the centre which influences patient outcomes in cancer care but the two are closely correlated [119]. It ought to follow that patients who travel beyond their closest hospital would be travelling to a cancer centre and so would be receiving care from a high volume, specialised team and due to this patient outcomes were closely assessed alongside travel times.

2.8.2 Patient choice

Patient perceptions of treatment are known to influence the decision making process with regards to choice of place of treatment, however it is not known to what extent this influences

patients' preference as to place of care. Overall self-reported patient satisfaction was higher for patients treated at a TCT centre[129 130] but little research exists as to whether patients chose to access specialist care, were referred as standard or attended as it was simply the closest centre to their residence.

2.8.3 Referral practice

Little is known about the influence of referral practice on the uptake of specialist care. Whilst it has been shown that referral patterns vary across the UK[36] it is not understood to what degree this influences the use of specialist care services compared to that of patient choice.

2.9 Delivery of care

2.9.1 Referral guidelines

The National Institute for Health and Clinical Excellence (NICE) have a guideline for the referral of suspected cancers to secondary and tertiary care entitled "Referral for Suspected Cancer"[131]. This was most recently updated in 2005 and provides a detailed outline of the cases where urgent referral is vital, symptoms which require immediate referral to a consultant and tests needed [132]. The two-week wait rule was introduced in 1998 in an attempt to improve outcomes for patients with cancer. For all suspected cancers this is set at a two week maximum wait and it is expected that a referral for suspected cancer should reach the NHS Trust within 24 hours of the patient's appointment with their general practitioner [133].

Referral guidelines vary from region to region across the UK and many are focused on a cancer site specific pathway, with the exception of paediatric referrals. It is important to quantify this variability and to attempt to understand the influence it has on both treatment and outcomes.

2.9.2 Treatment guidelines

The Department of Health have set guidelines as to the acceptable period for children and young adults to wait between a general practitioner's referral and the commencement of treatment. This is currently set at 62 days and applies to any diagnosis of cancer [133]. The DoH also states that treatment should begin no longer than 31 days after the patient has consented. During the first quarter of 2008 England had an 85.7% compliance rate to the one-month rule for children's cancers [133]. These rules again apply to both adult and children's cancers and so all teenagers and young adults ought to be seen within 62 days regardless of the type of malignancy. The Joint Council for Clinical Oncology (JCCO) guidelines state that patients, regardless of age, sex or cancer type should commence treatment within 21 days of a referral by a general practitioner [134]. The differing morphological and topological characteristics of cancer in teenagers and young adults mean that their treatment is also

varied. Chemotherapy, radiotherapy and surgery remain the mainstays of treatment in this age group, however there are few standard protocols used across the UK [125].

The Peer Review Cancer measures published by the Department of Health in 2004 state that systemic cancer therapy can be provided at any hospital providing they can obtain and administer the drugs in accordance with their guidelines. This means that there are few restrictions as to which hospitals can treat teenagers and young adults, providing the potential for greater variation in treatment practice nationally.

With regards to surgery the relatively low likelihood of a patient having co-morbidity means that teenagers and young adults tend to tolerate procedures well [125]. Teenagers and young adults tend to be less susceptible to the negative effects of radiotherapy and chemotherapy than younger or older patients [125]. However younger teenagers are still growing and radiotherapy to sites still undergoing development (such as the breasts and gonads) can cause serious late effects [125]. The greatest problem with chemotherapy in this age group is adherence to the regime, which can detract from its effectiveness [125]. Teenagers and young adults are known to be suitable to undergo more intensive treatments than older patients due to a better organ function [125]. The greatest problem with assessing the effectiveness of various treatments for the different morphological and topological types of cancer in teenagers and young adults is the wide range of different treatment regimes used and the essential lack of standardised treatment protocols specifically targeted at this age group. Teenagers and young adults are often treated using either paediatric or adult protocols, however the benefits and drawbacks of some of the more commonly used treatments may be examined.

There is known to be a variation in treatment by geographical region, age group, diagnostic group and treating centre. This variation should be quantified, and it is important to determine what effect this is having on patient outcomes.

Best practice guidelines for use in cancer care are evidence based and many draw from the outcome of clinical trials. In order to determine what level of care patients are receiving it is important not only to understand the gold standard of cancer care for each cancer type but also to be able to distinguish treatments with a curative intent from those which are best supportive care. Many curative treatments comprise of several treatment modalities, without one of which the treatment becomes less likely to be curative.

2.9.3 Leukaemia

Leukaemia is not surgically treated. For the most part it is treated using induction and consolidation chemotherapy, and in some cases, stem cell transplantation (SCT). Induction chemotherapy is used to induce remission, consolidation therapy is used during remission to

reduce the risk of relapse. The exact protocol used and the likelihood of SCT varies by morphology, karyotype, patient age and comorbidities. Chemotherapy in leukaemia usually requires an inpatient episode[135].

Stem cell transplantation requires high dose treatment prior to the actual transplantation. This involves high doses of chemotherapy and in some cases total body irradiation (TBI). Patients tend to remain as inpatients during high dose treatment and after transplantation, until blood counts have recovered.

Acute myeloid leukaemia (AML) is treated using induction and consolidation chemotherapy. Several standard regimens require continuous infusion of a chemotherapeutic substance over several days, often resulting in inpatient stays. SCT is often used in high risk patients during their first remission, or in patients who have had multiple relapses [136 137].

The only curative treatment for CML is stem cell transplantation, requiring a protracted stay in hospital [138].

2.9.4 Lymphoma

2.9.4.1 Non-Hodgkin's lymphoma (NHL)

The treatment for Non-Hodgkin's lymphoma depends on the histological type and stage of disease. Patients with diffuse large B-cell non-Hodgkin lymphoma should be treated with 6-8 cycles of chemotherapy combined with rituximab [139]. Follicular lymphoma patients with stage I-II disease can be treated with radiotherapy alone. Patients with later stage disease are often treated only when symptoms appear. Rituximab is used in conjunction with chemotherapy for the majority of these cases [140].

2.9.4.2 Hodgkin's lymphoma (HL)

The treatment of Hodgkin's lymphoma depends on the stage of the disease. Increasing numbers of cycles of chemo-radiotherapy are used with increasing stage. In young adults chemotherapy only regimens may be used due to the slightly lower long-term sequelae of treatment [141]. Relapsed patients may be treated using multiagent chemotherapy, high dose chemotherapy and autologous stem cell transplantation. Further relapse can be treated using reduced intensity conditioning allogeneic stem cell transplantation (RIC-allo) [141].

2.9.5 Central nervous system and other intracranial and intraspinal neoplasms (CNS)

Curative treatment for CNS tumours consists mainly of resection of the primary tumour, followed in most cases by radiotherapy or radiosurgery, especially when the surgical resection is considered to be incomplete. The treatment may vary dependent on the site of the tumour, with some being located in inoperable locations and therefore being treated primarily with radiotherapy or radiosurgery[142-150].

Ependymomas are commonly treated using surgery and radiotherapy, in certain cases chemotherapy may also be used[146]. As with ependymomas, oligodendrogliomas are also chemosensitive and so a chemotherapeutic agent may be included in the treatment plan[147]. Medulloblastoma and PNET tumours are treated using surgery, chemotherapy and/or radiotherapy[149].

2.9.6 Osseous and chondromatous neoplasms, Ewing's tumour and other neoplasms of bone

2.9.6.1 Osteosarcoma

Best practice guidelines for osteosarcoma vary depending on the grade of the tumour. Low grade tumours can be treated with a wide surgical excision alone [151]. For high grade osteosarcomas treatment with a curative intent consists of surgery and chemotherapy (pre and/or post-operative), with the majority of patients being suitable for limb salvage surgery[152]. Most chemotherapy takes place for between 6 and 12 months pre-operatively.

Radiotherapy is not employed as a curative treatment but can be used in palliative cases [152].

2.9.6.2 Chondrosarcoma

Grade 1 (low-grade) central and peripheral chondrosarcomas are managed by excision or curettage of the primary tumour. High grade chondrosarcomas and those of the pelvis and axial skeleton are treated using a wide excision. Very few chondrosarcomas are chemosensitive, with the exception of mesenchymal chondrosarcoma. This means that where a wide resection margin cannot be achieved amputation is often employed over adjuvant chemotherapy [153].

2.9.6.3 Ewing's sarcoma

Curative treatment for a Ewing's sarcoma of the bone should involve neoadjuvant chemotherapy, local treatment (surgery and/or radiotherapy) followed by adjuvant chemotherapy, with the full treatment cycle lasting between 8 and 12 months on average [154] [155].

Surgery is the preferred local treatment, as Ewing's sarcoma is radiosensitive radiotherapy can be used for patients where a clear resection margin was not achieved at surgery as well as for inoperable cases [153-155].

2.9.7 Soft tissue sarcomas (STS)

Surgery (with or without radiotherapy) is the mainstay of curative treatment for all adult STS, paediatric STS are also surgically treated if the intent is curative. Paediatric type tumours tend to be more chemosensitive than adult tumours so in these cases chemotherapy may be employed alongside radiotherapy and surgery in these cases [156] [157].

For STS located in an extremity and considered to be resectable, surgery is the mainstay of curative treatment. Adjuvant radiotherapy, and in some cases chemotherapy, may be utilised to ensure a clear surgical margin (R0 resection). Neoadjuvant radiotherapy may be used in high-grade tumours, low-grade tumours over a certain size and resections which were not considered to result in a clear margin (R1 or R2 resections) [156 157].

Soft tissue sarcomas located in an extremity which are not considered to be immediately resectable may be treated with radiotherapy in an attempt to render the tumour resectable. If successful a major resection is undertaken. In cases involving chemosensitive tumours combination chemoradiotherapy may be used to the same end [156].

Retroperitoneal and abdominal STS are treated using surgical resection with clear margins. Adjuvant radiotherapy is less frequently used in these cases due to restrictions in dose related to the proximity of radiosensitive organs [156].

2.9.8 Germ cell and trophoblastic neoplasms

2.9.8.1 Gonadal germ cell and trophoblastic neoplasms

Testicular germ cell tumours are treated by orchidectomy, either partial or total. Depending on the risk of relapse some cases are treated using adjuvant chemotherapy[158-160]. Seminomatous gonadal germ cell patients are commonly treated with adjuvant radiotherapy to reduce relapse rates [158 161]. As with testicular germ cells ovarian germ cell tumours are commonly surgically treated with postoperative chemotherapy/radiotherapy use depending on the tumour stage and the risk of relapse [158].

2.9.8.2 Non-gonadal germ cell tumours

Pineal germ cell tumours are often treated with chemotherapy prior to surgery[143]. For CNS germ cell tumours the therapy depends on the tumour site. Chemo-radiotherapy and/or surgical resection are the most commonly used curative treatments [162]. Mediastinal tumours are usually surgically resected after neoadjuvant chemotherapy [163].

2.9.9 Melanoma and skin carcinoma

2.9.9.1 Melanoma

The treatment of melanoma varies slightly depending on the stage of disease. The mainstay of curative treatment for all cases is a wide excision of the primary tumour with clear excision margins (R0 resection) [164 165], however there is a debate as to what is a suitable clear margin [166]. In cases where regional lymph nodes are affected these may also be removed during surgery [164].

Adjuvant therapy may be used in high risk cases (high grade), however there is no standard practice in these cases [164], immunotherapy has been trialled, but optimal timing has not been

determined [165]. Systemic therapy may be used in palliative cases, radiotherapy is often used to treat patients with symptomatic metastases [164].

2.9.9.2 Skin carcinoma

The majority of skin carcinomas can be classified as either basal cell or squamous cell, these are called non-melanoma skin carcinoma (NMSC). The most commonly used treatments for NMSC are surgical resection resulting in clear margins and radiotherapy [167] [168]. Surgical approaches used may include Mohs micrographic surgery (MMS), cryosurgery, electrodessication and curettage, and standard surgical resection [168]. Radiation therapy may be utilised as first line or adjuvant therapy.

Photodynamic therapy, as with radiation therapy, can be used as first line treatment in cases of in situ squamous cell and basal cell carcinomas. Deeper carcinomas often require surgical resection [167-169]. This also applies for the use of topical chemotherapy, applied directly to the lesion, often by the patient [168].

2.9.10 Carcinomas

2.9.10.1 Thyroid

Differentiated thyroid cancers (DTC) consist of follicular and papillary cancers. The primary curative treatment for DTC is surgery, be it a total or partial thyroidectomy or a lobectomy. In the majority of cases this is then followed by radioiodine ablation, with the exception of low stage (T1) tumours, with no metastases [170] [171].

Medullary thyroid cancers (MTC) are less common than DTC but the initial treatment is similar with the majority of non-metastatic patients undergoing a thyroidectomy, extended to include a central lymph node dissection in a large proportion of cases [171].

2.9.10.2 Head and neck

2.9.10.2.1 Nasopharyngeal carcinoma

Nasopharyngeal carcinoma is unusual within the solid tumours in that the mainstay of potential curative treatment is radiotherapy. Radiotherapy is targeted at the primary tumour and also at local regions considered to be at risk of spread. Later stage disease may be treated with chemo-radiotherapy rather than radiotherapy alone [172].

Recurrent cases tend to be treated using a combination of surgery and radiotherapy, with or without chemotherapy, whilst metastatic cases are often treated using chemotherapy alone[172].

2.9.10.2.2 Other sites in head and neck

Curative treatment depends on the site of the primary tumour. Early stage tumours are often treated using surgery or radiotherapy. Later stage disease is treated using surgery and neoadjuvant radiotherapy or chemo-radiotherapy. For some anatomical sites neoadjuvant chemotherapy may be utilised [173].

2.9.10.3 Trachea, bronchus, lung and pleura

Lung cancer can be broadly grouped into small-cell and non-small-cell tumours. Limited (a tumour which can be covered by a single radiation port) small-cell lung cancer is treated using chemotherapy and thoracic radiotherapy. Very localised cases (T1-T2, N0) can also be offered a radical resection. More extensive disease is treated using chemotherapy alone [174]. In all cases prophylactic cranial irradiation may be used to reduce the risk of brain relapse [174].

The treatment of non-small-cell lung cancer depends mainly on the stage of the tumour. Surgical resection is a curative option for surgically fit patients. Adjuvant therapy is used in later stage cases. Neoadjuvant therapy can be utilised in patients with positive nodes. Adjuvant radiotherapy is utilised when surgical margins are not considered to be clear [175]. Stage IV disease is treated with chemotherapy as first-line treatment [175].

2.9.10.4 Breast

Patients with a susceptibility to breast cancer, normally a BRCA mutation, may be offered prophylactic treatment. This ranges from chemoprevention to bilateral mastectomy [176].

Non-invasive breast carcinoma can be treated with breast conserving surgery (BCS), only if clear margins can be achieved. If this is not possible then mastectomy may be used. Patients with ER+ve tumours may be offered tamoxifen [177].

Invasive carcinomas are also surgically treated, either using BCS or mastectomy depending on the prognostic factors. If BCS is used or there are multiple positive local nodes then radiotherapy is often used post operatively. Advanced cancers are treated using neoadjuvant chemotherapy. If the patient is deemed at high risk of recurrence then adjuvant treatment is also used. The hormone status of the tumour determines the use of endocrine treatment such as Herceptin [177].

2.9.10.5 Genito-urinary tract

2.9.10.5.1 Kidney

Encapsulated kidney cancer is treated surgically by a partial or total nephrectomy. Metastatic kidney cancer is also treated surgically but this may be followed by systemic multi-agent chemotherapy [178].

2.9.10.5.2 Bladder

The majority of bladder cancers are removed by transurethral resection (TUR). The follow up treatment varies by risk factor. For low risk tumours TUR is followed by a single course of chemotherapy, medium risk tumours with multiple courses of chemotherapeutic agents and high risk with bacille Calmette-Guerin (BCG) [179]. Tumours which invade the muscle are treated with radical cystectomy and lymphadenectomy, if the patient is not fit for this operation external beam radiotherapy may be used. In palliative cases multi-agent platinum based chemotherapy may be utilised [179].

2.9.10.5.3 Ovary

The treatment for ovarian carcinoma, as with many other sites, depends on the age of the patient, stage of disease and prognostic factors. Early stage disease (FIGO stage I and IIa) are surgically treated, usually involving a total hysterectomy, bilateral salpingo-oophorectomy, omentectomy and pelvic node dissection. In patients wishing to maintain fertility a unilateral salpingo-oophorectomy may be performed. Low grade tumours with poor prognostic factors, such as poor differentiation and large size may also be treated with chemotherapy post surgery [180]. More advanced cases are also surgically treated with adjuvant chemotherapy, usually given once every three weeks for 6 cycles [180]. In highly specialised centres intraperitoneal chemotherapy may be given.

Patients with advanced disease (FIGO stage IV) are often de-bulked surgically followed by chemotherapy [180].

2.9.10.5.4 Cervix

Curative treatment for cervical cancer is dependent on the patients age, co-morbidities and prognostic factors of the tumour, including stage. Early stage tumours (FIGO stage IA1 and IA2) are commonly treated surgically, with conisation or hysterectomy. For patients with clear margins the only follow up needed is surgical, for patients with involved or threatened margins, involved nodes or a large tumour postoperative pelvic radiotherapy or chemo-radiotherapy may be used [181].

Later stage tumours (FIGO stage IB1) are treated using one or a combination of the following; surgery, brachytherapy, radio-surgery or external radiotherapy [181]. Stages IB2- IVA are often treated using chemoradiotherapy, stage IVB tumours often receive combination chemotherapy alone. Palliative cases are treated using chemotherapy, or radiotherapy if it has not been used before. In some cases a pelvic exenteration is undertaken [181].

2.9.10.6 Gastrointestinal tract

2.9.10.6.1 Colon and rectum

As with breast cancer, colorectal cancer in young patients is often associated with an increased familial cancer risk. Syndromes such as Lynch syndrome, familial adenomatous polyposis (FAP) and MUTYH-associated polyposis (MAP) are associated with an increased risk of colorectal cancer. Patients may be referred for screening and surveillance if a number of first degree relatives develop colorectal cancer. This may lead to prophylactic surgery in some cases and higher than average levels of endoscopic polypectomy [182].

The primary treatment for colorectal cancer is surgical removal of the primary tumour, with or without an extended removal of a larger section of the bowel to ensure clear margins. Adjuvant therapy may be given where the margins were not clear or the tumour was considered to be high risk [183]. Studies have shown that neoadjuvant radiotherapy may offer a survival benefit and a reduced risk of recurrence in patients with operable rectal tumours [184].

2.9.10.6.2 Stomach

Carcinoma of the stomach can only be cured using surgery. The type of surgery, ranging from endoscopic mucosal resection (EMR) to radical gastrectomy, depends on the depth of invasion and extent of disease. Surgical resection may also include the exenteration of other local organs if direct invasion is seen. Neoadjuvant chemo-radiotherapy has been shown to improve survival in some cases [185]. Palliative cases are treated using multiagent chemotherapy [185].

2.9.10.6.3 Liver and intrahepatic bile ducts

Cholangiocarcinoma is one of a group of primary liver cancers, the only curative treatment for this treatment is complete surgical resection, including lymphadenectomy and an en bloc hepatic resection [186].

The treatment of choice for hepatocellular carcinoma which is considered to be resectable is a surgical resection without adjuvant therapy. Total removal of the liver and liver transplantation may be employed when the tumour is multifocal, not considered to be locally resectable or where the patient is found to have a cirrhosis [187]. Trans-arterial chemoembolization (TACE) and radiofrequency ablation may be used in certain multifocal cases.

2.9.10.6.4 Pancreas

Extensive surgery is the only curative treatment for pancreatic cancer, however this is only suitable for early stage cancers and the majority of pancreatic cancers are diagnosed at a late

stage. The type of resection depends on the location of the tumour within the pancreas. In some cases adjuvant chemotherapy may be utilised [188].

Chemo-radiotherapy may be used in later stage cases. Endoscopic stents are used to ease jaundice in palliative cases[188].

2.9.10.6.5 Oesophagus

Oesophageal cancer is again treated using surgery as the mainstay of curative treatment, however this can only be applied when the tumour is localised. Patients unfit for a resection may be treated using chemo-radiotherapy. More advanced tumours are treated using neoadjuvant chemo-radiotherapy before a radical resection [189].

2.9.11 Clinical trials

2.9.11.1 Benefits of clinical trials

Teenagers and young adults have different treatment needs and incidence patterns than either paediatric, adult or geriatric cancer patients. This means that they tend not to fit into the criteria specified for clinical trials [49 51 190]. Fern et al in 2008 discovered that there were few trials which were open to patients aged 15-24 years[49], in all only 16.6% of TYA patients were enrolled on a trial. However they also found that in several cases where the age eligibility criteria allowed the inclusion of TYAs few patients over the age of 16 were included. In the case of four brain cancer trials with upper age limits of between 18 and 21 only patients aged less than 15 were included [49]. This demonstrates that it is not merely the entry criteria which are causing the low uptake in this age group. There is a large amount of evidence to show that adult and paediatric patients who partake in a clinical trial have a better outcome [44 49 191] . Teenagers and young adults who are treated in clinical trials have been shown to have greatly improved survival rates, however the majority of trials which they are enrolled into are not targeted to their age group and they tend to be involved in paediatric or adult trials. In France, the USA and the Netherlands a study into the recurrence rates and survival of 16 to 21 year old patients with acute lymphoblastic leukaemia showed that those treated in paediatric trials did significantly better than patients in the same age range on adult trials [44]. This shows the benefits of clinical trials for the treatment of cancer in teenagers and young adults but also demonstrates a need for more age specific trials.

2.9.11.2 Accrual of teenage and young adult patients to clinical trials

Accrual of teenagers and young adults to clinical trials is disappointingly low when compared to that of adults and children, below 14. Approximately 70% of children in the developed world with cancer enter clinical trials [192] . Multiple reports have demonstrated the decline in study participation for teenagers and young adults. In England, Scotland and Wales 56% of cancer

patients aged 5-14 are involved in trials, compared to only 20% of 15-24 year olds [192]. A more recent study has shown a similar pattern with accrual rates of 43.2% in patients aged between 10 and 14 years, 25.2% in those aged between 15 and 19 and a further decrease to 13.1% in those aged 20-24 years [49]. 80% of cancer patients aged 0- 14 in Italy are enrolled in clinical trials, in contrast only 25%-30% of patients between 15 and 24 years of age participate [192]. This has also been demonstrated by several studies in the USA. Between 1997 and 2003 involvement of 15- 19 year olds was between 10% and 15 % [105 193] . For patients between 20 and 30 years of age this rate decreased to 2% of all patients [105 193 194]. This is less than 5% of the number of children who were involved in trials in the same time period and approximately half the number of adult [194]. Accrual rates for TYAs were found to vary between cancer types, with the accrual for TYAs with leukaemia, CNS tumours and osteosarcoma between 2005 and 2007 lower than that of children [49]. An exception to this rule was male germ cell tumours where only patients above the age of 14 were found to have been entered onto trials[49].

There is a large amount of speculation as to why the accrual rate of teenagers and young adults to clinical trials is so low when compared to children and adults. One factor is a lack of trials available for teenagers and young adults. Adult and paediatric cancer centres may not have appropriate protocols for the treatment of teenagers and young adults. Some patients may be excluded from trials on the basis of their age, many paediatric trials have an upper age limit of 16- 18 whilst many adult clinical trials have a set lower age limit [195 196]. Trial age entry criteria can often divide the age incidence spectrum of teenage and young adult cancers which can result in different treatment approaches being used [192]. As the spectrum of cancers which tend to occur in patients between 15 and 24 years differs greatly from both common adult and childhood cancers neither paediatric oncologists nor adult oncologists tend to run trials on these cancers [197].

2.10 Morbidity and survival

2.10.1 Morbidity

Survival is not the only measurable outcome from cancer in TYA patients. Many of the treatments used in this group are associated with high levels of morbidity, occurring throughout treatment and for a significant time after the completion of treatment[198-200]. Second malignant neoplasms and recurrences also affect the quality of life of TYA patients post treatment[201 202]. These early and late effects affect the health service usage of these patients for the remainder of their lives.

2.10.1.1 *Effects of treatment*

Treatment effects for TYA patients can be broadly grouped into two subgroups, early effects and late effects. Immediate effects of treatment include unplanned return to surgery, infections and prolonged stay in hospital. These can be used to assess the level of specialisation of care a patient is receiving and also determine the effect on the patient's life.

The impact of cancer on teenagers and young adults extends beyond the primary and on-going treatment for the malignancy. Treatment for cancer is highly toxic and often has long term effects. Long-term survivors of cancer have been shown to be at a greater risk of developing second and subsequent malignant neoplasms (SMNs), this is often considered to be late sequelae of their original treatment [203]. Treatment related complications, loss of or reduction in fertility and recurrences of the primary neoplasm are also common late effects within the TYA group [200].

Hospital usage (inpatient and outpatient) can be used as a measure of long lasting effects on TYA patients.

2.10.1.2 *Loss of fertility*

Many studies into the concerns which affect teenagers and young adults undergoing cancer treatment have cited loss of fertility as a major issue. Even low doses of radiation can result in permanent ovarian failure and increase the rates of miscarriage, intrauterine growth retardation and premature delivery [204]. Higher miscarriage rates are seen in women whose ovaries were within the radiation field [205].Infertility rates have been shown to be higher in males than females, however in this case fertility preservation is more successful [200 204 206]. Both chemotherapy and radiotherapy have been shown to have an effect on ovarian function[204 207].

2.10.1.3 *Recurrence of the primary cancer and occurrence of second and subsequent malignancies*

Studies have shown that the majority of late mortality can be linked to recurrence of the primary malignancy [200]. It is the most common cause of late death in long-term survivors of childhood and teenage cancers [200].

There have been several studies examining the risk of developing a second cancer after radiotherapy for a first cancer. The Late Effects Study Group (LESG) demonstrated that approximately 12% of children and adolescent (<20 years of age) survivors from a first cancer developed a second cancer after 25 years from diagnosis [208-211]. The risk of developing thyroid cancer, osteosarcoma, and soft tissue sarcoma, melanoma and brain tumours increased with an increased radiation dose[212 213]. Bone, thyroid, CNS and breast cancers have been shown by a study using the Childhood Cancer Survivor Study (CCSS) to be the most commonly occurring

second malignancies [203 206 214]. Although these are reported for survivors of childhood cancer it is important to consider the implications for TYA patients. An original diagnosis of soft tissue sarcoma, acute lymphoblastic leukaemia and Hodgkin's lymphoma was associated with an increased risk of developing a second malignancy [206 210 215 216]. Hodgkin's lymphoma carries the greatest risk of developing an SMN, as does treatment with anthracyclines and epipodophyllotoxins [217]. One established association is between treatment for Hodgkin's lymphoma and radiation induced breast cancer, the risk is again proportional to the dose of radiation [218 219].

One possible explanation for the increased risk of developing SMNs associated with certain malignancies is the delivery of radiation to particularly sensitive tissues (thyroid) or treatment to tissues which are proliferating rapidly due to growth. This phenomenon is seen in children, teenagers and young adults who are still growing and so have a large amount of proliferating tissue. Another potential causative factor is the treatment regimes used to treat teenagers and young adults. As mentioned previously anthracyclines and epipodophyllotoxins are associated with a greater risk of developing SMNs, as are alkylating agents. These have been shown to have a link with increased risk of developing bone cancers and soft tissue sarcomas [217]. Therapy related acute leukaemia as a SMN is associated with the use of alkylating agents, topoisomerase II inhibitors, anthracyclines and platinum compounds [217].

2.10.1.4 Other effects of treatment

The highly toxic nature of the majority of treatments for cancer often result in damage to organ systems, myelosuppression and cardiac damage and is the second most common cause of late mortality in survivors of TYA and childhood cancers, surpassed only by recurrences of the primary neoplasm [200]. There is an increased risk of non-neoplastic fatal complications amongst survivors of ALL, Hodgkin's disease and CNS tumours when compared to other malignancies seen amongst the TYA group [200]. Congestive heart failure is associated with the use of anthracyclines therapy and Mediastinal radiation [200]. Pulmonary fibrosis, acute pulmonary toxicity and restrictive lung disease are also associated with chemotherapy and radiotherapy [200]. Late toxicity effects have also been seen in the hepatic, renal and gastrointestinal systems [200].

2.10.1.5 Other quality of life issues

Several of the commonly studied treatment plans for TYA cancers have been linked to decreasing bone density and increasing osteoporosis. The most commonly studied are the treatment and clinical factors associated with acute lymphoblastic leukaemia (ALL) [220 221].

Alongside the physiological issues there are other psychological quality of life issues for teenagers and young adults. The most commonly studied of these are;

- Abnormal perceptions of their body and increased level of hypochondria.
- Increased levels of risk taking behaviour.
- Persistent anxiety about a relapse or other health related issues [125].

2.10.2 Survival

2.10.2.1 Age and survival

Several studies have shown that younger patients have a better survival rate from leukaemia and CNS tumours, whereas they have worse survival from germ cell tumours [103 222]. Survival from lymphomas, bone tumours, soft tissue sarcomas, melanomas and carcinomas does not appear to be associated with age [103]. The survival of patients from breast and colorectal cancer and Ewing's sarcoma has been shown to be inversely proportional to age [222]. In the case of breast and colorectal cancer, survival for individuals under 50 years of age is particularly poor independent of stage of disease at presentation [222]. This is interesting as poor survival from cancer is commonly related to later stage at diagnosis, more aggressive tumours and other co-morbidities. As teenagers are less likely than their adult counterparts to be suffering from multiple co-morbidities the other two factors must have greater influence. Cancers commonly believed to be those of childhood often have poorer survival rates in teenagers and young adults when compared to children. For example Wilm's tumour, retinoblastoma and rhabdomyosarcoma have all been shown to have lower survival rates in teenagers and young adults [222]. With the exception of non-Hodgkin's lymphoma survival rates are found to be significantly worse for teenagers and young adults with leukaemia than children with the same disease [55].

2.10.2.2 Temporal changes in survival

There has been a temporal improvement in survival from all cancers. In teenagers and young adults the improvement varies by morphological and topological type as well as age group, gender, ethnicity and deprivation. A study using Canadian data showed survival rates in children to have increased by 40% between 1975 and 1998 compared to only 25% for adolescents in the same time period [113].The Surveillance Epidemiology and End Results (SEER) group showed there to be an average annual improvement in survival in children under 15 years and adults over 50 of approximately 1.5%, however in patients aged 15 to 24 years this improvement decreased to 0.5% annually [45 193].A study of French data showed the five year survival rates for teenagers and young adults with cancer to be 74.5% between 1988 and 1997 with an 8% increase during the study period [223]. This is supported by another study which showed relative survival to increase from 63% at the beginning of the study (1979) to 77% at

the end of the study [51]. There was no improvement shown in this study for patients suffering from soft tissue sarcomas [51] . Germ cell tumours had consistently high survival rates across all age ranges, genders and time period [51]. As with teenagers and young adults the survival rate of children with cancer has increased drastically in recent decades. However the improvement in survival of children has been greater than that of teenagers and young adults. For both age groups the improvement in survival has been greater in Western Europe than Eastern Europe [55]. It has been shown by A. Bleyer that in 1975 5 year survival for patients aged 15 to 19 years was 64%; however in children it was 55%. By 1990, five year survival of the older patients had increased to 76% and to 75% in the younger patients [44 103]. This demonstrates the greater improvement in the younger age group.

2.10.2.3 Geographical variation in survival

Geographically there is a wide variation in survival to five years after diagnosis of cancer in teenagers and young adults. Survival in European countries is a good example of this, several eastern European countries; Czech Republic, Poland and Slovakia have survival to five years which is lower than the European average (75% in males and 78% in females). Estonia has particularly low survival to five years (approximately 40%) [55]. The more recent data from EUROCARE-4 shows that there was a reduction in the geographical difference in survival between 1995 and 2002[56]. This could be a result of the more recent data used in the EUROCARE-4 study. The survival of patients to five years also varies geographically by topology and morphology. Ewing's sarcoma, bone cancers, astrocytoma, CNS cancers and testicular germ cell tumours vary widely across Europe [55]. When survival in Central and Southern Europe, UK, Eastern Europe and Northern Europe was examined Northern Europe was shown by one study to have the highest survival rates for Hodgkin's lymphoma, non-Hodgkin's lymphoma, ALL, germ cell tumours, melanoma, CNS tumours, soft tissue sarcomas, cervical, colon and breast cancers [55]. Eastern Europe had the worst survival for all the afore mentioned malignancies with the exception of breast cancer [55]. The UK had the best survival for ALL, and good survival for non-Hodgkin's lymphoma and gonadal germ cell tumours when compared to the rest of Europe. The greatest geographical variation by morphological type was seen in the five year survival for neuroblastoma and hepatic tumours in Europe, both more frequently seen in younger patients. CNS tumours, germ cell tumours, leukaemia and lymphomas showed much smaller geographical variation [91].

A study comparing EUROCARE-3 data and SEER data for the survival of patients with Hodgkin's disease found that survival in EUROCARE UK and EUROCARE East were similar to each other but significantly below that of the SEER data, however when the data was adjusted to allow for

morphological type the survival of SEER and EUROCARE UK were the same suggesting that there is a significant international geographical difference in morphological type [68].

There is a clear link between geographical location and survival, however there are some flaws with several of the geographical studies. Completeness of follow up information varies by country, region and cancer registry and so may affect analysis. Within country variation needs to be taken into account when looking at an entire country. Results may also be affected by other factors, such as screening programs, classification schemes and completeness of follow up.

This study seeks to examine the geographical variation in referral pathways, treatment and the associated effect this is having on survival.

2.10.2.4 Gender and survival

Gender also appears to influence the outcome for malignancies in teenagers and young adults. With the exception of germ cell tumours female patients tend to have better survival than male patients [51 53 55 56 64 88 125]. Gender differences in survival are not only seen in TYA patients but also in younger children and older adults and have been widely studied in the context of colorectal, lung and bladder malignancies [224-229] .

2.10.2.5 Deprivation and survival

Socioeconomic deprivation is known to be a factor, which affects both survival and outcome in older and younger patients[125 230-232]. However its effect on TYAs with cancer has not been as widely studied. Several of the more common malignancies of the TYA age group are known to be associated with increasing incidence in the more affluent groups, such as non-Hodgkin's lymphoma. This would imply an association between level of deprivation and survival in this group, which could be assessed alongside its connection with other factors, such as referral pathways and treatment.

Deprivation is commonly associated with poorer survival from cancers of adulthood, such as colorectal cancers [233]. This is in certain cases due to late presentation or lower uptake of screening programmes [233]. However this relationship is not as widely studied in reference to cancers of the teenage years and young adulthood. A study examining this relationship in Yorkshire has shown that unlike cancers of adulthood, the effect of deprivation on survival in TYAs varies depending on the cancer type. For example CNS tumours were shown to have poorer survival in areas of medium affluence[234]. A nationwide study found there to be no association between deprivation and survival, however it also found that this may have been affected by the variation in incidence of some malignancies nationwide [235].

2.10.2.6 Tumour biology and survival

Malignant melanoma is considered to be one of the most common cancers of teenagers and young adults but has one of the best overall cure rates of all the cancers diagnosed in this age group. The overall cure rate often exceeds 90%, however for patients suffering from metastatic disease the five year survival rate is considered to be less than 15% [1]. The survival rate from many cancers of the teenage and young adult years varies depending on the morphological type, this emphasises the importance of using a coding method which involved morphology alongside topology. Examples of this are testicular and ovarian cancer, the cure rate for testicular seminomas and ovarian dysgerminomas exceed 90% but there is a greatly reduced cure rate for other morphological types [1].

In patients aged 13 to 29 years of age in England and Wales the malignancies with the highest mortality rates between 1981 and 2005 were as follows;

- Central nervous system tumours
- Myeloid and monocytic leukaemia
- Lymphoid leukaemia
- Bone tumours
- Non-Hodgkin's lymphoma

These five groups accounted for 50% of deaths in this study [235].

A study using EUROCARE-3 data examining the effect of morphology on the survival from non-Hodgkin's lymphoma showed that morphological type had an effect. Lymphoblastic, diffuse B, other T cell, Burkitt's and mantle cell/ centrocytic lymphoma had worse outcomes than other types of NHL [236]. The effect of different morphological types on survival from Hodgkin's lymphoma and leukaemia have also been studied and there has been shown to be an association [236]. Data from EUROCARE-4 shows Hodgkin's lymphoma to have the highest survival in teenagers and young adults between 1995 and 2002 (93% to five years).

Cancers which are considered rare in teenagers and young adults often have a worse prognosis than in older patients. Breast and gastric cancers are a good example of this. Breast cancer in patients under 30 years of age is often more aggressive and the tumours are more likely to be triple negative for hormone receptors (oestrogen, progesterone and HER2) [237].

During the early 1970's teenagers and young adults had better survival rates than younger patients. However, a slower rate of progress has meant that survival rates for patients aged less than 15 years now exceeds that of older patients [44].

In the USA cancer is the leading non accidental cause of mortality amongst teenagers and young adults (Figure 14), exceeded only by accidental injuries, suicide and murder [46 64 135] and is

the leading cause of disease related death in England and Canada [51 74]. In the UK it is the most common non-accidental cause of death in people aged between 15 and 24 and accounted for 8% of deaths in male TYA between 2007 and 2009 (Figure 12) and 14% of deaths in female TYA (Figure 13) in the same time period. A large majority of the cancer mortality burden for TYA consists of sarcomas, leukaemia, lymphoma, CNS tumours and germ cell tumours [103 238] .

Figure 12: The 4 most common causes of death in males by age, UK, 2007-2009

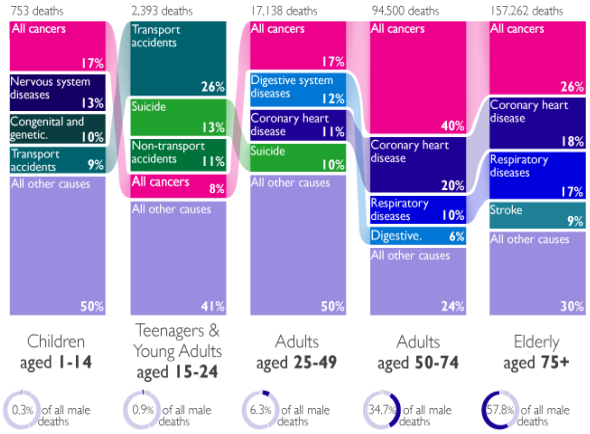
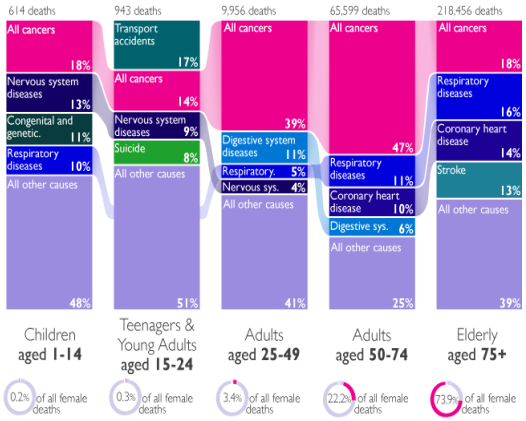
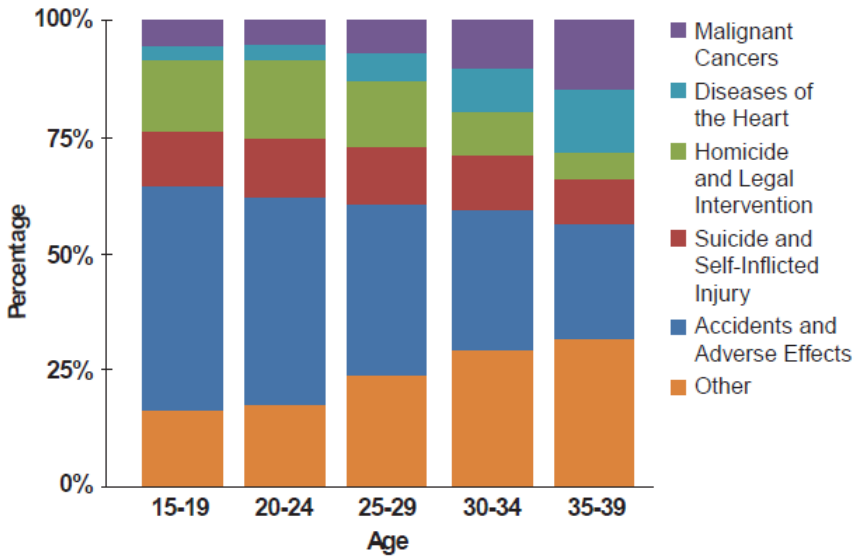


Figure 13: The 4 most common causes of death in females by age, UK, 2007-2009



Source: Cancer Research UK (CRUK), 2012

Figure 14: Common causes of death amongst AYA's in the United States [239]



**U.S. deaths, 2005. Underlying mortality data provided by the National Center for Health Statistics.*

Chapter 3 Methods

This chapter explains the methods used to achieve the key aims of the study. Firstly the rationale behind the choice of study period, area and population are described. This is followed by a detailed description of the data the study is based upon and the steps taken to 'clean' and quality assure the raw data and produce a robust analytical study dataset. It then continues to detail the descriptive and statistical methods used to achieve each of the three key study objectives described below;

I. To produce a definition of specialist care for TYA and investigate the proportion of care spent in a specialist environment by different demographic groups.

II. To describe variation in pathways nationally in England by investigating the relationship between travel time and attendance at specialist centres.

III. To determine the effect of the level of specialist care received on patient outcomes including health service resource use, cost and survival.

3.1 Study design

Due to the nature of the available data and the questions to be answered this was a retrospective observational study using population-based routine healthcare data.

3.2 Study period

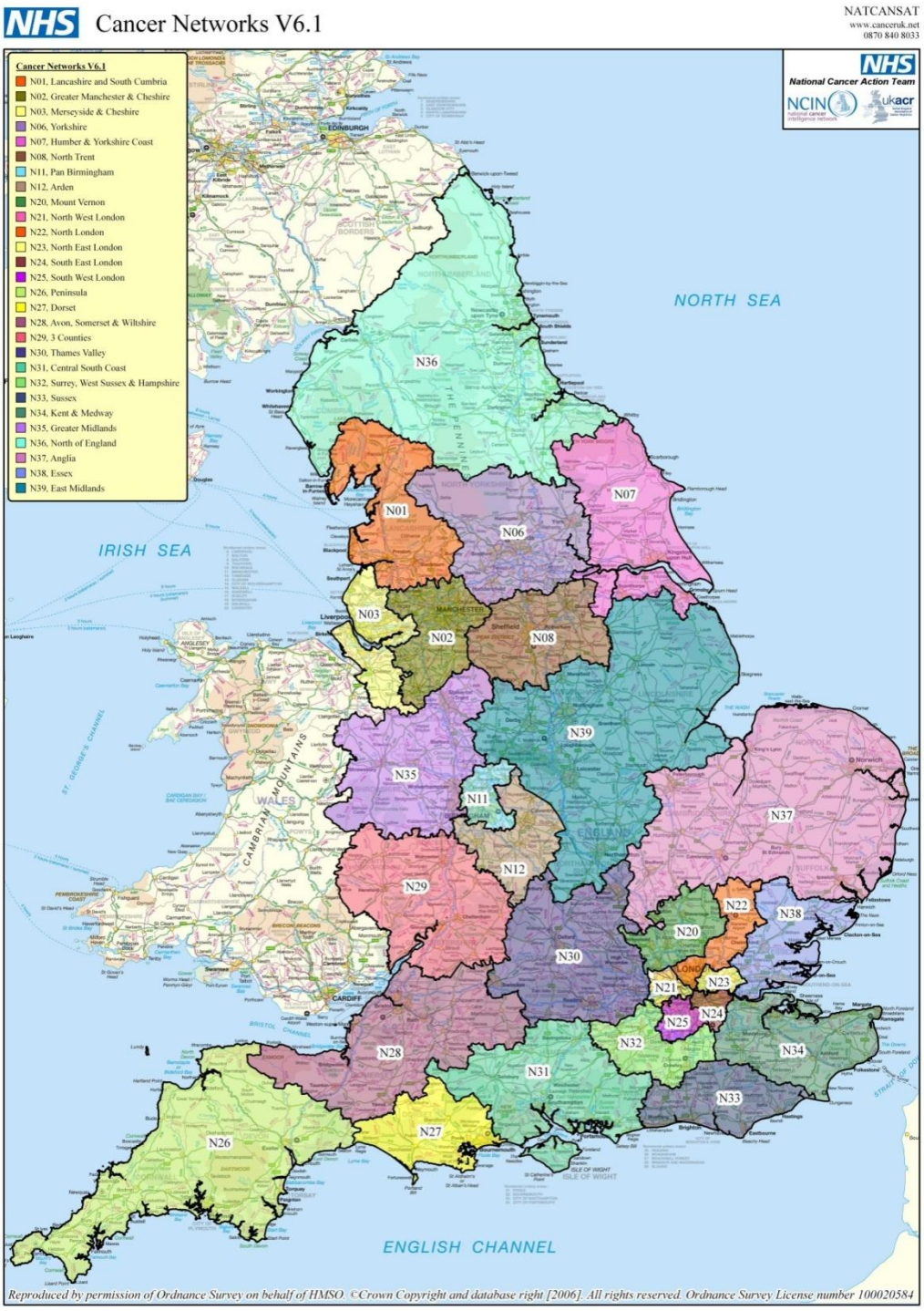
The study period chosen spanned from 2001 to 2006 and all TYA patients diagnosed between these dates were eligible for inclusion. Hospital admissions for all the individuals in this cohort were available up until 2009. This study period was chosen for multiple reasons. Firstly, the Improving Outcomes Guidelines (IOG) for children and young people were released in 2005 and so this period encompassed diagnoses and treatment both pre- and post- their issue. This study period enabled, therefore, the influence of these guidelines on practice to be assessed. Also, limiting the cohort to patients diagnosed up to 2006 ensured there was a minimum of three years follow up for each patient so allowing three-year survival analyses to be undertaken.

3.3 Study area

The study area of England was chosen. This was primarily because high quality population-data were available for this area. The health and cancer geography of England can be divided in multiple different ways, but for this study analyses were undertaken at cancer network level Map 1.

Cancer networks were suggested in the Calman-Hine report[5] and implemented as part of the NHS Cancer Plan in 2000[6]. Cancer networks are clinical networks which are responsible for co-ordinating, commissioning and organising care through from primary to tertiary settings and involve Primary Care Trusts (PCTs) and NHS Trusts. The principle aim of these was to improve cancer outcomes and patient experiences and so each cancer network has a series of multi-disciplinary teams (MDT) with overarching responsibility for the treatment of patients within the network, within which there are trust level MDTs. Additionally cancer networks are named as the body responsible for ensuring access to clinical trials and availability of specialist centres alongside coordination of referral processes and treatment pathways. Cancer networks cover a larger area than a single NHS trust and organise access to specialist centres making them the ideal geography for use in this study. Over the time period of this study there were 28 cancer networks managing cancer service in England. Their geographical coverage is detailed in Map 1.

Map 1: The study area



3.4 Data sources

3.4.1 National Cancer Data Repository (NCDR)

This study was based on data held in the 2008 iteration of the National Cancer Data Repository (NCDR)[240]. This resource was created by the National Cancer Intelligence Network (NCIN)[241] and is formed of multiple routine NHS cancer datasets linked at a patient level. This means that it provides detailed information on all persons diagnosed with cancer in England. The two

main components of the dataset are cancer registration data[242] and Hospital Episode statistics (HES)[243].

The cancer registration dataset is comprised of data supplied from each of the eight English cancer registries pooled into a single national dataset. It includes basic demographic, diagnostic, treatment and death information for every cancer diagnosed in England. Unfortunately, however, it contains little information on treatment and management of these cancers and so these data are linked at a patient level to HES data.

HES data is episode based and includes information on all in-patient and day case admissions to NHS hospitals since 1997. It also includes data on private sector patients treated at NHS hospitals or funded by the NHS. The HES data records a wide range of information including diagnostic and treatment information relating to every inpatient episode. Demographic, hospital and physician information are also included. Linkage of the two datasets enables the management and outcome of all cancer patients in England treated in NHS hospitals to be tracked, providing the information required to investigate the influence of specialist care for TYA patients.

But, both cancer registry and HES data are routine datasets which are not designed for epidemiological research. As a result the raw dataset required 'cleaning' to remove duplicates and to clarify some of the diagnostic coding.

3.4.1.1 Data quality

There are acknowledged problems with the data, including duplicate registrations, incorrect coding and missing data. Where possible, methods were utilised which sought to avoid bias from this. These methods are described in this chapter.

One significant, and unavoidable, problem affected the linkage of HES data to cancer registry data. HES data were only available for patients who had been admitted to hospital, and who had a diagnosis of cancer recorded during an admission. Patients who received treatment as an outpatient only, mostly melanoma and skin carcinoma patients, were excluded as there was no treatment information available. An additional group of patients were excluded as, despite having been admitted to hospital there was no HES data available in the dataset provided as they had no cancer diagnosis recorded in the data at any point. It was not possible to determine whether there was a linkage failure due to either of the two reasons described above or whether it was caused by a mismatch of linkage information (date of birth, NHS number etc.) and so all patients who failed to link were excluded. This may have biased the results of the study in that a particular subset of patients may have been more likely to be excluded than others, however the study population analysis (Chapter 4) suggests that this was not a significant problem.

Another acknowledged problem with the linked dataset is that it is not possible to determine whether information, such as diagnostic codes, were missing or truly ought to have been left blank. This meant it was not possible to assess the completeness of treatment and diagnostic data, or to draw any conclusions from the missingness of data in certain fields.

Treatment information is a key part of any analysis of cancer outcomes, however there is known to be variation in the quality and completeness of the treatment information available in HES and cancer registry data. As previously stated it is not possible to determine when a field is blank due to missing information or whether it is blank as the patient did not have that intervention/treatment/diagnosis. An audit of patients from the Leeds area (Table 5) showed that major surgical resections were relatively consistently recorded whilst additional therapy was reported with varying accuracy. This only covered a small group of patients but reflects what is thought to happen in England as a whole. It was not possible to do anything to address this in the course of this project.

It was important to identify duplicated patients prior to analysis as this could have biased the results due to duplication of patient outcomes. Duplicates may have arisen for many reasons. TYA are a highly mobile population and may travel substantial distances for treatment. This may mean that they cross cancer registry boundaries and as a result may be registered in multiple locations. The national cancer registration dataset on which this study is based on pooled data from eight registries and so multiple registries may have recorded the same cancer leading to duplicate registrations. Likewise it is possible that tumours may have been mistakenly recorded multiple times by the same registry. Identifying and resolving these data problems was vital prior to analysis and required several stages depending on the reason for the duplication. Due to these problems a bespoke set of de-duplication guidelines were created for this project.

3.5 Data cleaning

3.5.1 Cancer registration data

Firstly, each tumour was allocated to a diagnostic category based on the Birch classification scheme (Table 2). This classification scheme assigns tumours to groups based on their morphology and the anatomical site of the tumour. All those in groups 1-10 were retained in the dataset. As this project focuses on malignant cancers those registrations determined to be benign were excluded (Table 1). Hydatidiform moles (International Statistical Classification of Diseases and Related Health Problems (ICD) code O01.9) were also excluded due to inconsistent registration nationally. Likewise neurofibromatosis (an umbrella name for a number of genetic conditions which cause multiple (often benign) tumours in the central nervous system) was also excluded.

Table 1: Benign and in situ diagnoses included regardless of behaviour code.

ICD10 group		ICD10 subgroup	
Code	**Description**	**Code**	**Description**
D32	Benign neoplasm of meninges	D32.0	Cerebral meninges
		D32.1	Spinal meninges
		D32.9	Meninges, unspecified
D33	Benign neoplasm of brain and other parts of central nervous system	D33.0	Brain, supratentorial
		D33.1	Brain, infratentorial
		D33.2	Brain, unspecified
		D33.3	Cranial nerves
		D33.4	Spinal cord
		D33.7	Other specified parts of central nervous system
		D33.9	Central nervous system, unspecified
D35	Benign neoplasm of other and unspecified endocrine glands	D35.2	Pituitary gland
		D35.3	Craniopharyngeal duct
		D35.4	Pineal gland
D42	Neoplasm of uncertain or unknown behaviour of meninges	D42.0	Cerebral meninges
		D42.1	Spinal meninges
		D42.9	Meninges, unspecified
D43	Neoplasm of uncertain or unknown behaviour of brain and central nervous system	D43.0	Brain, supratentorial
		D43.1	Brain, infratentorial
		D43.2	Brain, unspecified
		D43.3	Cranial nerves
		D43.4	Spinal cord
		D43.7	Other parts of central nervous system
		D43.9	Central nervous system, unspecified
D44	Neoplasm of uncertain or unknown behaviour of endocrine glands	D44.3	Pituitary gland
		D44.4	Craniopharyngeal duct
		D44.5	Pineal gland

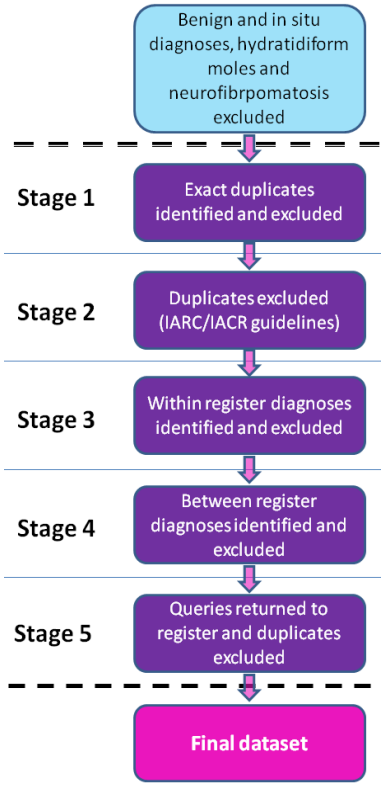
Table 2: Birch/Alston tumour groups

Group 1	Leukaemia's
Group 2	Lymphomas
Group 3	Central Nervous system and other intracranial and intraspinal neoplasms
Group 4	Osseous and chondromatous neoplasms, Ewing sarcoma and other neoplasms of bone.
Group 5	Soft tissue sarcomas
Group 6	Germ cell and trophoblastic neoplasms
Group 7	Melanoma and skin carcinoma
Group 8	Carcinomas
Group 9	Miscellaneous neoplasms NEC
Group 10	Unspecified malignant neoplasms NEC
9998	Benign and in situ diagnoses

During the reclassification process a group of tumours were identified for which the site code and morphology code were incompatible. These were also excluded, alongside these tumours which fell into either group 9 or 10 were excluded. This was due to the wide range of tumour biology encompassed by the two groups and the small number of patients, making meaningful analysis impossible for the purpose of this project.

The following steps were then taken to 'clean' the remaining data. A schematic of this is shown in Figure 15.

Figure 15: Cancer registration data cleaning process



3.5.1.1 Stage one - duplicate records

Exact duplicates, those which matched on all fields, were identified and all but one record was excluded from the dataset.

3.5.1.2 Stage two - duplicate tumours

Duplicate records were identified. Firstly, guidelines from the International Agency for Research on Cancer (IARC) and International Association of Cancer Registries (IACR) for multiple primaries were applied to the data in order to exclude duplicate diagnoses[244]. These guidelines recognise a primary cancer as one which is not an extension, recurrence or metastasis of another. ICD codes are used to assess the likelihood of a tumour being a primary or incorrect registration. Multifocal or multiple tumours arising in paired organs are recorded as a single diagnosis. Multicentric cancers, such as leukaemia, should only be recorded once in each individual. Multiple tumours in the same organ with different morphologies are considered to be separate primary diagnoses.

Secondly, records which were a match on patient characteristics, diagnosis information and geographical details, but not additional information such as treatment details (surgery Y/N, chemotherapy Y/N and radiotherapy Y/N) were identified and, after manual review, all but one of the records were excluded from the dataset.

Tumours with a site code which could be bilateral (i.e. occurring in both of a paired set of organs such as the kidneys or testes) were assessed separately. The tumour site codes determined to potentially be bilateral are listed in Table 3. The laterality and diagnosis dates were checked in all cases and all records which appeared to be recurrences or multiple primaries were excluded.

Patient numbers are assigned by cancer registries to uniquely identify a single patient within that registry. Tumour numbers, also assigned by the cancer registries, identify tumours uniquely. One patient may have multiple tumour numbers associated with them depending on the number of diagnoses. Multiple tumours diagnosed close together with the same patient number but different tumour numbers suggests genuine multiple diagnoses, however multiple diagnoses with different patient numbers are suggestive of duplication and were checked.

3.5.1.3 Stage three – within register duplicates

Patients with multiple diagnoses within one register were then identified using patient identifiers (NHS number, date of birth, sex, cancer registry patient number). Records which were suspected to be duplicates rather than multiple primaries were manually double checked. For records differing on the last digit of the site code the most specific was kept, e.g. C40.1 versus C40.9 use C40.1. This rule only applies to diagnoses which could not be bilateral.

If the site was potentially bilateral the tumours were checked as with cross register duplicates. As recorded in the IACR/IARC guidelines for tumour registration, tumours at the same site with different morphology should be recorded as separate tumours. However if the tumour number is the same for both records the most specific morphology code was kept.

3.5.1.4 Stage four – cross register duplicates

Patients with a diagnosis in two or more registers were then identified using patient identifiers (NHS number, date of birth, sex). Where the diagnoses were deemed to be duplicated (close diagnosis date, similar site code) the record from the registry of residence was kept. This register was identified using the patient's postcode at diagnosis. If the site code or diagnosis date differed significantly the tumours were re-assessed in a later stage (Stage 6). Tumours with a site code which could be bilateral were also assessed separately.

3.5.1.5 Stage five – queries returned to register

Any suspected duplicates which could not be cross checked using the rules above were returned to the registry in question along with the alternative diagnosis site/morphology/diagnosis date. The records were then cross checked against the additional information held by the registers and a decision was made as to which record, if any, should be dropped from the final dataset. If there was disagreement between the registers as to which record was correct the reasoning behind the decisions was examined and a decision was made based on the information available. Codes for secondary tumours, systemic disease and multiple primaries (Table 4) were excluded from the deduplication process.

Table 3: Bilateral tumour sites

ICD10 group		ICD10 subgroup	
Code	**Description**	**Code**	**Description**
C07	Parotid gland		
C09	Tonsil	C09.0	Tonsillar fossa
		C90.1	Tonsillar pillar
		C09.8	Overlapping lesion of tonsil
		C09.9	Tonsil, unspecified
C30	Nasal cavity and middle ear	C30.1	Middle ear
C31	Accessory sinuses	C31.0	Maxillary sinus
		C31.1	Ethmoidal sinus
		C31.3	Sphenoidal sinus
		C31.8	Overlapping lesion of accessory sinuses
		C31.9	Accessory sinus, unspecified
C34	Bronchus and lung	C34.0	Main bronchus
		C34.1	Upper lobe, bronchus or lung
		C34.2	Middle lobe, bronchus or lung
		C34.3	Lower lobe, bronchus or lung
		C34.8	Overlapping lesion of bronchus and lung
		C34.9	Bronchus or lung, unspecified
C40	Bone and articular cartilage of limbs	C40.0	Scapula and long bones of upper limb
		C40.1	Short bones of upper limb
		C40.2	Long bones of lower limb
		C40.3	Short bones of lower limb
		C40.8	Overlapping lesion of bone and articular cartilage of limbs
		C40.9	Bone and articular cartilage of limb, unspecified
C43	Melanoma of skin	C43.1	Eyelid, including canthus
		C43.2	Ear and external auricular canal
		C43.6	Upper limb, including shoulder
		C43.7	Lower limb, including hip
C47	Peripheral nerves and autonomic nervous system	C47.1	Peripheral nerves of upper limb, including shoulder
		C47.2	Peripheral nerves of lower limb, including hip
C49	Other connective tissue and soft tissue	C49.1	Connective and soft tissue of upper limb, including shoulder
		C49.2	Connective and soft tissue of lower limb, including hip
C50	Breast		
C51	Vulva	C51.0	Labium majus
		C51.1	Labium minus
C56	Ovary		
C57	Other and unspecified female genital organs	C57.1	Fallopian tube
		C57.8	Overlapping lesion of female genital organs
C62	Testis	C62.0	Undescended testis
		C62.1	Descended testis
		C62.9	Testis, unspecified
C63	Other and unspecified male genital organs	C63.0	Epididymis
		C63.1	Spermatic cord
		C63.7	Seminal vesicles
		C63.9	Male genital organ, unspecified
C64	Kidney, except renal pelvis		
C65	Renal pelvis		
C66	Ureter		
C69	Eye and adnexa	C69.0	Conjunctiva
		C69.1	Cornea
		C69.2	Retina
		C69.3	Choroid
		C69.4	Ciliary body
		C69.5	Lacrimal gland and duct
		C69.6	Orbit
		C69.8	Overlapping lesion of eye and adnexa
		C69.9	Eye, unspecified
C72	Spinal cord, cranial nerves and other parts of central nervous system	C72.2	Olfactory nerve
		C72.3	Optic nerve
		C72.4	Acoustic nerve
C74	Adrenal gland	C74.0	Cortex of adrenal gland
		C74.1	Medulla of adrenal gland
		C74.9	Adrenal gland, unspecified
C76	Other and ill-defined sites	C76.4	Upper limb
		C76.5	Lower limb

Table 4: Secondary tumours and metastatic spread

ICD10 group		ICD10 subgroup	
Code	**Description**	**Code**	**Description**
C77	Secondray and unspecified malignant neoplasm of lymphnodes	C77.0	Lymph nodes of head, face and neck
		C77.1	Intrathoracic lymph nodes
		C77.2	intra-abdominal lymph nodes
		C77.3	Axillary and upper limb lymph nodes
		C77.4	Inguinal and lower limb lymph nodes
		C77.5	Intrapelvic lymph nodes
		C77.8	Lymph nodes of multiple regions
		C77.8	Lymph node, unspecified
C78	Secondary malignant neoplasm of respiratory and digestive organs	C78.0	Lung
		C78.1	Mediastinum
		C78.2	Pleura
		C78.3	Other and unspecified respiratory organd
		C78.4	Small intestine
		C78.5	Large intestine and rectum
		C78.6	Retroperitoneum and peritoneum
		C78.7	Liver
		C78.8	Other and unspecified digestive organs
C79	Secondary malignant neoplasm of other sites	C78.0	Kidney and renal pelvis
		C79.1	Bladder and other and unspecified urinary organs
		C79.2	Skin
		C79.3	Brain and cerebral meninges
		C79.4	Other and unspecified parts of nervous system
		C79.5	Bone and bone marrow
		C79.6	Ovary
		C79.7	Adrenal gland
		C79.8	Other specified sites

3.5.2 Hospital episode statistics data

Similarly to cancer registry data, duplicates existed in the HES dataset with several copies of the same admission being recorded in some cases. These were identified by ascertaining whether more than one admission began on the same date for a single patient and then cross checking this against admission reasons, procedure codes and treating physician code.

Episodes of care (a period under the care of a single consultant) are grouped into spells or admissions. A spell can have multiple episodes contained within it. These spells were re-calculated for each patient due to known coding issues in the HES data. This resulted in a new identifier for each admission and cross checked admission and discharge dates.

3.5.2.1 Coding of treatment in hospital episode statistics data

One caveat of the HES data is the known variability of the coding of treatment. HES data is used as part of the Payment by Results (PbR) process and so it is likely that the missing treatment data is skewed towards those treatments associated with a lower cost. In order to check the extent of the problem for this project a small audit of treatment data was undertaken for patients residing in the Northern and Yorkshire Cancer Registry and Information Service (NYCRIS) region. In total 1326 patients were identified, access to hospital records and additional clinical information was possible for 522 of these patients (Table 5). Overall, major surgical resection of a malignancy was only marginally under reported in HES

when compared directly to medical records. Chemotherapy was slightly under reported in HES for those with a haematological malignancy and those with germ cell neoplasms, however there was a relatively small difference in the number of cases identified using the two methods. The greatest difference was seen in the reporting of radiotherapy, with an additional 35 cases being identified using medical records. These differences were not unexpected and support the need for caution when interpreting results relating to treatment, they do however demonstrate the relative accuracy of HES data when used to identify major surgery.

Table 5: Assessment of completeness of treatment information for patients in the NYCRIS region, comparing HES data to hospital records

				Treatment recorded											
				Surgery				Chemotherapy				Radiotherapy			
	Patients in the NYCRIS region			HES		Medical records		HES		Medical records		HES		Medical records	
Diagnostic group	Total	Not checked*	Checked **	n	%	n	%	n	%	n	%	n	%	n	%
Leukaemia	134	61	73	0	*0.0*	0	*0*	63	*86.3*	64	*87.7*	20	*27.4*	26	*35.6*
Lymphoma	252	87	165	0	*0.0*	0	*0*	150	*90.9*	155	*93.9*	43	*26.1*	80	*48.5*
Central nervous system and other intracranial and intraspinal neoplasms	138	108	30	26	*86.7*	27	*90.0*	26	*86.7*	10	*33.3*	13	*43.3*	16	*53.3*
Osseous and chondromatous neoplasms, Ewing's sarcoma and other neoplasms of bone	83	51	32	23	*71.9*	24	*75.0*	28	*87.5*	24	*75.0*	14	*43.8*	12	*37.5*
Soft tissue sarcoma	64	42	22	18	*81.8*	19	*86.4*	15	*68.2*	11	*50.0*	13	*59.1*	6	*27.3*
Germ cell and trophoblastic neoplasms	198	108	90	81	*90.0*	83	*92.2*	79	*87.8*	80	*88.9*	21	*23.3*	22	*24.4*
Melanoma and skin carcinoma	226	191	35	34	*97.1*	34	*97.1*	2	*5.7*	3	*8.6*	0	*0.0*	2	*5.7*
Carcinomas	231	156	75	70	*93.3*	71	*94.7*	27	*36.0*	27	*36.0*	43	*57.3*	38	*50.7*
Overall	**1326**	**804**	**522**	**252**	***48.3***	**258**	***49.4***	**390**	***74.7***	**374**	***71.6***	**167**	***32.0***	**202**	***38.7***

* Records were not available for checking due to lack of access to records at the treating centre **Treatment information cross checked using clinical notes and pathology reports

3.6 Exclusions from the analysis dataset

Patients for whom no HES linkage was possible were excluded from the analysis as it was not possible to say whether these patients had failed to link due to a lack of admissions or whether there were differences in the identifiers used to link the datasets. This meant that it was not possible to draw any conclusions about the level of specialist inpatient care received by this group.

Patients who had previously been diagnosed with a malignancy, pre-2001, were also excluded from the analysis as the treatment for a second malignancy may differ from that of a primary diagnosis due to dose restrictions for chemotherapy and radiotherapy.

Information for admissions during the treatment period were analysed for this study as the aim was to assess the impact of specialist care, which occurs during the active treatment phase. For solid tumours the treatment period was defined as being a month before diagnosis to 18 months post diagnosis. This was to encompass diagnoses occurring during an admission to hospital and also to include the vast majority of admissions which were treatment related. The treatment period for haematological malignancies was defined as beginning a month

before diagnosis and ending three years post diagnosis, in order to include all treatment-related admissions. Admissions outside these time frames were not included in the analysis.

3.7 Attitudes towards specialist care

In an attempt to understand the reasons behind the variation in place of treatment for TYA patients the variation in attitudes towards specialist care amongst medical professionals caring for this group was assessed.

Medical professionals from NHS Trusts across the UK involved in the treatment of TYA patients were identified using NHS websites. An online survey was distributed via email to over 600 professionals.

A list of statements encompassing both age appropriate and site specific aspects of care were compiled from areas of interest identified in the literature and listed in Table 6. Respondents were asked to rate the 17 statements from 1 to 5 depending on the level of importance assigned to them (1 – low importance to 5- high importance). Questions regarding the age range that respondents deemed appropriate for TYA patients, speciality and affiliation with a teenage cancer trust (TCT) unit were also included.

Analysis of the responses was performed using Latent Gold 4.5[245], a statistical package designed for latent class modelling, a method used to establish underlying characteristics and relationships used to group the data into natural/latent classes. This was utilised to establish underlying relationships or patterns which grouped the respondents into distinct classes. Questions which did not define the groups were excluded from the analysis.

This preliminary work demonstrated the difficulty in defining specialist care for this age group, with different groups of health care providers rating certain aspects differently to each other. In order to fully define specialist care, data from other sources such as patient opinions and survival, and treatment results from different providers, need to be used to help refine the results of the web survey.

Table 6: Statements used in the survey of professionals

Specialist type	Question	
Site	1	Treatment by a site specific surgical or medical team
	2	Diagnostics and staging by a site specialist team (radiology, pathology, etc.)
	3	Access to site specific clinical trials
	4	Inpatient treatment on a site specific ward (e.g. Breast)
	5	Contact with a site specific clinical nurse specialist or Macmillan nurse
	6	Regular follow up by a site specific MDT
	7	Psychosocial and psychological support from those specialising in the care of persons with cancer
	8	Access to site specific palliative care if needed
	9	Access to site specific end of treatment care and support and information on late effects
Age	10	Treatment by a medical or surgical team who specialise in the treatment and care of TYA
	11	Diagnostics and staging by clinical teams specialising in the care of TYA
	12	Access to age appropriate clinical trials
	13	Treatment in an age appropriate environment
	14	Contact with a nurse specialising in the care of TYA
	15	Regular follow up by and age specific MDT
	16	Psychosocial and psychological support from those specialising in TYA
	17	Access to age appropriate palliative care if needed
	18	Access to age appropriate end of treatment care and support and information on late effects
General	19	Treatment at a high volume cancer centre
	20	Treatment at a hospital in close proximity to a patients home address
	21	Contact with peers who have undergone or are undergoing similar treatments or have a similar diagnosis
	22	Outpatient appointments in an age appropriate environment
	23	Educational and employment support during and after treatment
	24	Support for family, friends and partners of the patient
	25	Treatment by the same team throughout
	26	Access to fertility specialists and advice on reproductive issues
	27	Ability to stay in contact with peers when in hospital, facebook, email, etc.

3.8 Location of specialist care centres

Over the time period of this study a number of 'specialist' TYA centres existed in England. As this study aimed to investigate who in the TYA cancer population accessed these centres and their influence on care, information was required on their location and remit.

Between 2001 and 2009 a number of Teenage Cancer Trust (TCT) centres were open to TYA patients. These were identified using the TCT website (http://www.teenagecancertrust.org/) where information on their opening date was also sourced before being cross checked with the NHS Trust in question. The location of each centre was mapped using the coordinates of the hospital in which it was located (Map 2). Specialist centres existed for the treatment of bone and brain tumours and soft tissue sarcomas.

Brain and central nervous system (CNS) centres were identified with assistance from the Brain Tumour Charity[246] and the NHS trusts in question. At the time of this study there were 24 CNS centres in England acting as tertiary centres for the treatment of brain and CNS tumours. Their location is shown in Map 3.

The Bone Cancer Research Trust, Sarcoma UK and the websites of NHS trusts aided in the identification of the 16 soft tissue sarcoma (STS) specialist centres in England that operated during the period of study (Map 5). These centres provided specialist surgery or chemo/radiotherapy for patients diagnosed with a soft tissue sarcoma.

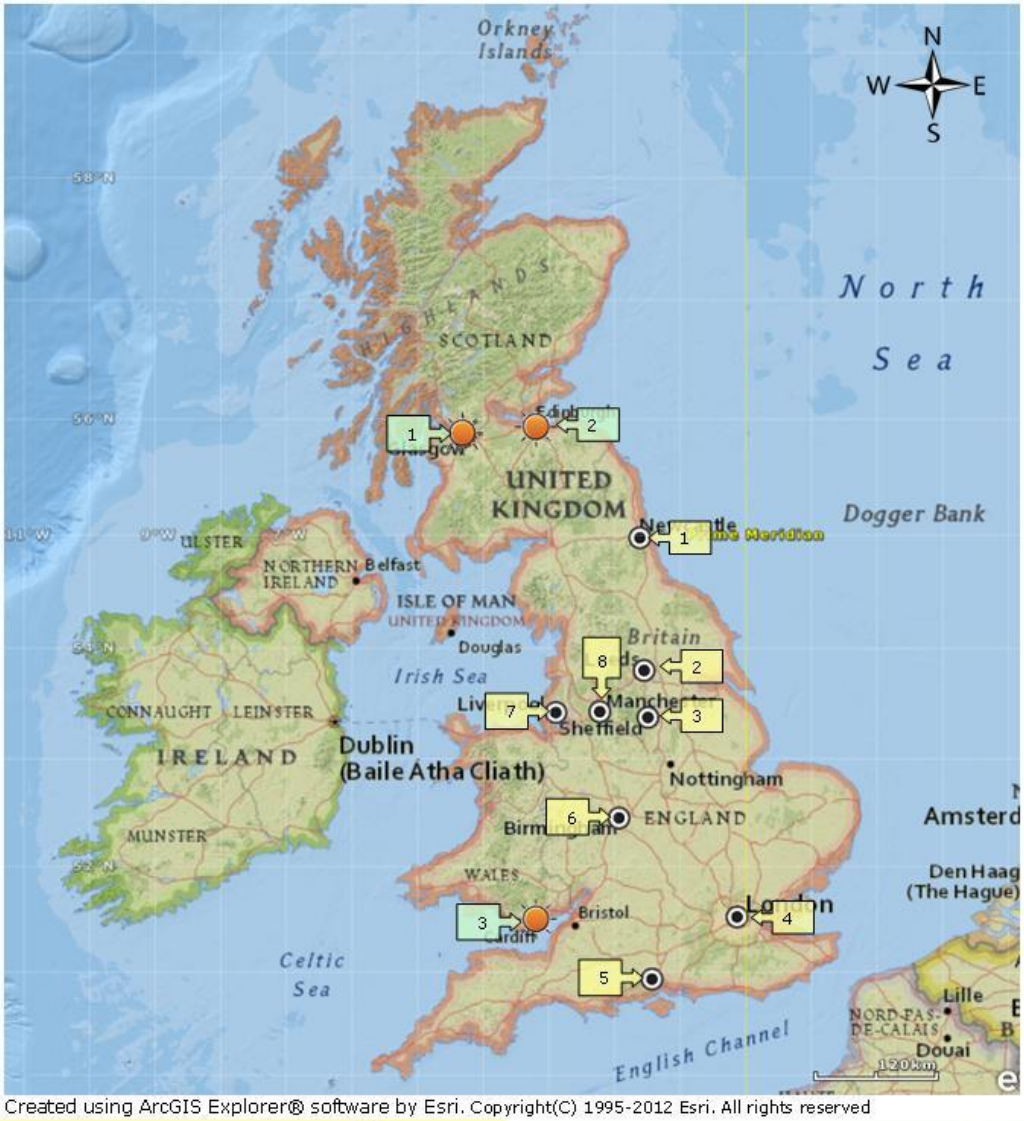
For bone tumour patients the specialist centres were identified using the National Specialist Services group. There were five centres operating as bone tumour specialist centres over the time period of this study (Map 4) and policy recommended that only these centres perform surgical resection of the tumours[124]. These guidelines were released in 2006 meaning that the place of care was a key analysis for this group. Additional therapy could be provided elsewhere, but only with the input of the team from the specialist centre at which the patient was receiving surgical treatment.

Some centres, such as Southampton, opened part way through the study period. Others had an upper age limit which prevented some of the patients in the study cohort from being admitted there. These restrictions were taken into account when modelling the access to specialist centres and patients were assigned to the closest centre for which they met the criteria (Table 7).

Table 7: Location and opening dates of Teenage Cancer Trust centres open during the study period (2001-2009)

Country	City	Hospital	NHS Trust/ Health Board	Provider code	Opening year	Lower age limit	Upper age limit
England	London	University College Hospital	University College London Hospitals NHS Foundation Trust	RRK	1990	13	24
	Manchester	The Christie	The Christie NHS Foundation Trust	RBV	1998	16	24
	Newcastle	Royal Victoria Infirmary	The Newcastle upon Tyne Hospital NHS Foundation Trust	RTD	1998	13	19
	Leeds	Leeds General Informary & St James's University Hospital	Leeds Teaching Hospitals NHS Trust	RR8	1998	13	24
	Birmingham	Queen Elizabeth Hospital	University Hospitals Birmingham NHS Foundation Trust	RRK	2000	13	24
	Sheffield	Weston Park Hospital	Sheffield Teaching Hospitals NHS Foundation Trust	RHQ	2002	16	24
	Liverpool	Alder Hey Children's Hospital	Ander Hey Childern's NHS Foundation Trust	RBS	2003	13	19
	Southampton	Southampton General Hospital	University Hospital Southampton NHS Foundation Trust	RHM	2009	16	24
Wales	Cardiff	University Hospital of Wales	Cardiff and Vale University Health Board		2009	13	24
Scotland	Glasgow	Royal Hospital for Sick Children (Yorkhill)	NHS Greater Glasgow & Clyde		2009	13	16
	Glasgow	Beatson West of Scotland Cancer Centre	NHS Greater Glasgow & Clyde		2007	16	24
	Edinburgh	Royal Hospital for Sick Children	NHS Lothian		2009	13	16

Map 2: Location of TCT centres in the UK (2001-2009)



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Units open during the study, England

1 – Royal Victoria, Newcastle

2 –Leeds General Infirmary & St James's Hospital, Leeds

3 - Weston Park Hospital, Sheffield

4 – University College Hospital, London

5 – Southampton University Hospital, Southampton

6 – Queen Elizabeth Hospital, Birmingham

7 – Alder Hey Children's Hospital, Liverpool

8 – The Christie, Manchester

Units open during the study, Scotland

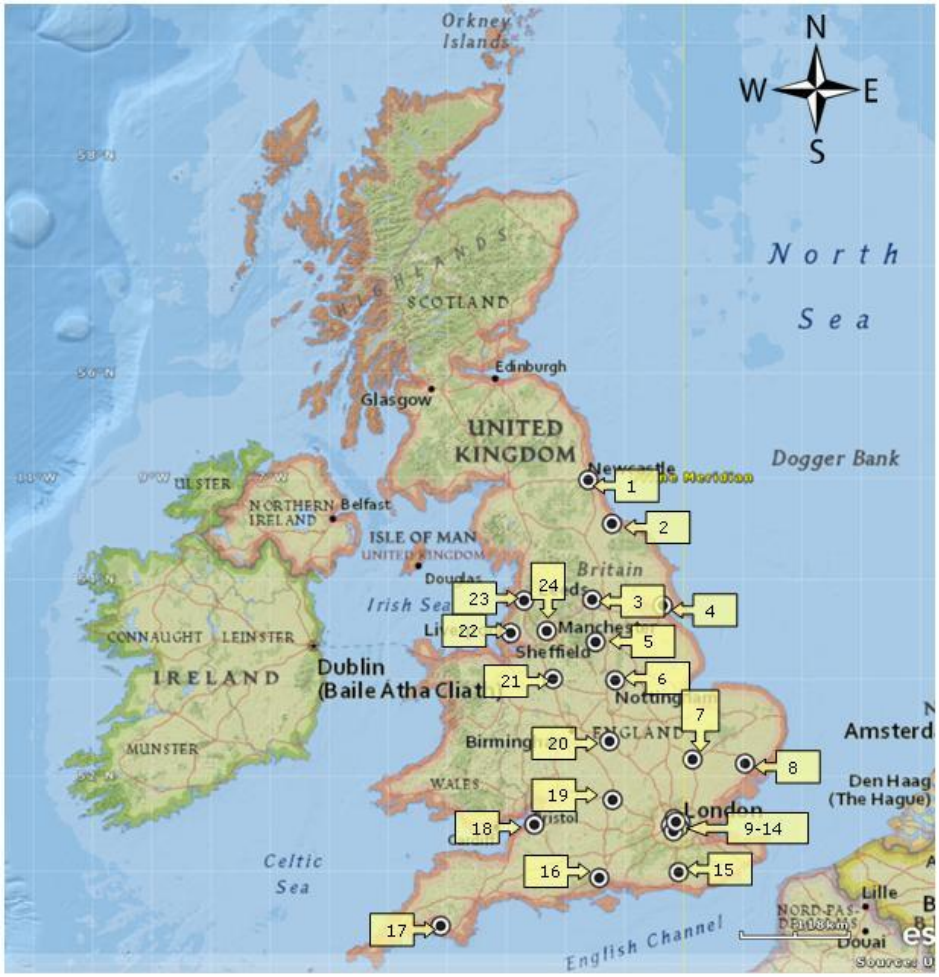
1 – Royal Hospital for Sick Children (Yorkhill) & Beatson West of Scotland Cancer Centre, Glasgow

2 - Royal Hospital for Sick Children, Edinburgh

Units open during the study, Wales

3 – University Hospital of Wales, Cardiff

Map 3: Location of CNS specialist centres in England (2001-2009)



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1 – Freeman Hospital, Newcastle
2 – James Cook University Hospital, Middlesbrough
3 – Leeds General Infirmary
4 - Hull Royal Infirmary
5 – Royal Hallamshire Hospital, Sheffield
6 – Queens Medical Centre, Nottingham
7 – Addenbrooke's Hospital, Cambridge
8 – Queen's Hospital, Romford
9 – St Georges Medical Centre, London
10 – King's College Hospital, London
11 – Charing Cross Hospital, London
12 – Royal Free Hospital, London
13 – Barts and The London Cancer Centre
14 - National Hospital for Neurology and Neurosurgery, London
15 – Sussex Cancer Centre, Brighton
16 – Southampton University Hospital
17 – Derriford Hospital, Plymouth
18 – Frenchay Hospital, Bristol
19 – Churchill Hospital, Oxford
20 – University Hospital, Coventry
21 – North Staffordshire Hospital, Stoke on Trent
22 – The Walton Centre for Neurosurgery, Liverpool
23 – Royal Preston Hospital
24 – Hope Hospital, Salford

Map 4: Location of bone tumour specialist centres in England (2001-2009)

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Units open during the study, England

1 – Freeman Hospital, Newcastle

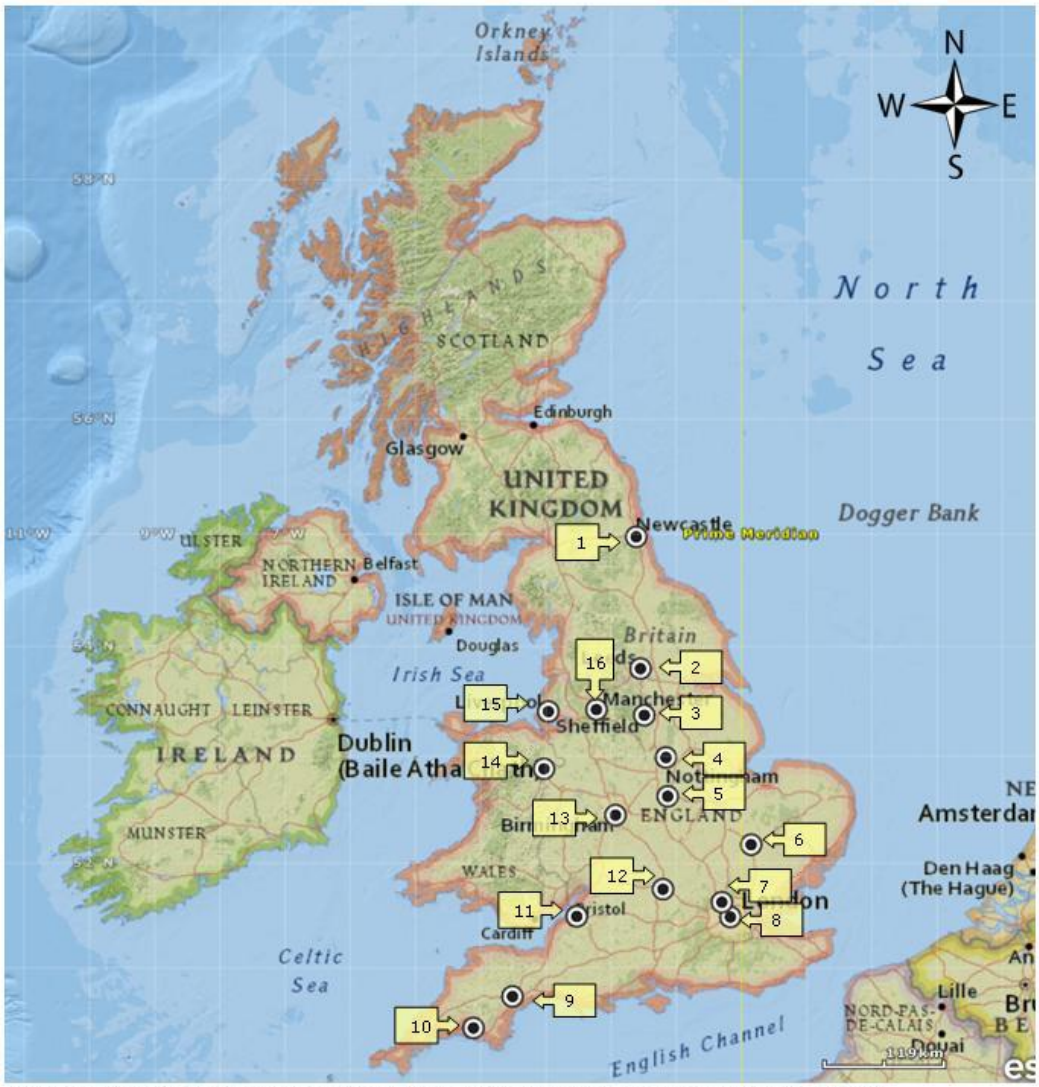
2 – Royal National Orthopaedic Hospital, Stanmore

3 – Nuffield Orthopaedic Centre, Oxford

4 – Royal Orthopaedic Hospital, Birmingham

5 – Robert Jones & Agnes Hunt Orthopaedic Hospital, Oswestry

Map 5: Location of STS specialist centres in England (2001-2009)



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1 – Freeman Hospital, Newcastle

2 – St James's Hospital, Leeds

3 – Royal Hallamshire & Weston Park Hospitals, Sheffield

4 – Nottingham City Hospital, Nottingham

5 – Leicester University Hospitals

6 – Addebrookes Hospital, Cambridge

7 – Royal National Orthopaedic Hospital, Stanmore

8 – The Royal Marsden Hospital

9 – Royal Devon & Exeter Hospital, Exeter

10 – Derriford Hosiptal, Plymouth

11 – Bristol Sarcoma Service, Bristol

12 – Churchill Hospital, Oxford

13 – Royal Orthopaedic Hospital & University Hospital Birmingham

14 – Robert Jones & Agnes Hunt Orthopaedic Hospital, Oswestry

15 – Royal Liverpool University Hospital, Liverpool

16 – Manchester Royal Infirmary & The Christie, Manchester

3.9 Definition of specialist care

In order to assess the influence of specialist care on outcomes it was first vital to determine what specialist care is for this age group. A measure of specialist care was, therefore, produced for each of the diagnostic groups. Defining what constitutes specialist care for this group is, however, difficult and the metric produced needed to encompass age- and site- specialist factors. Age-appropriate specialist care is intrinsically linked with site-specific specialist care in a majority of cases. In addition, as the level of exposure to specialist care was deemed potentially important factors such as length of stay were also incorporated into the metric.

The metric required to assign each patient to a level of specialist care needed to include several measures that encompassed both age-and site-specialist care. Age-appropriate and site-specific measures were included alongside more general measures of the quality of care such as length of inpatient stay.

3.9.1 Levels of specialist care

In order to address the varying number of admissions and length of stay between diagnostic and patient groups it was decided to examine the proportion of the total inpatient stay spent in a specialist centre rather than to use a binary variable (yes/no) or a count of the number of admissions.

The proportion of total inpatient time during treatment spent at a specialist centre was compared to the time spent at any other type of hospital for leukaemia, lymphoma, germ cell tumours, melanoma and carcinoma.

For diagnostic groups with centralised services (CNS and bone tumours and STS) the time spent in a TCT unit was compared to the time spent in a site specific specialist centre in order to encompass both age- and site- specific care. The results seen during this comparison are presented at the beginning of the results chapters.

Patients in each diagnostic group were assigned to one of three 'levels' of specialist care depending on the proportion of the total time spent as an inpatient in one of the specialist centres described previously. The distribution of the data led to the following 'levels';

Limited specialist input – less than 30% of the total inpatient period spent in a specialist centre.

Some specialist input – between 30% and 60% of the total inpatient period spent in a specialist centre.

Mostly specialist care – greater than 60% of the total inpatient period spent in a specialist centre.

In cases where patients could have both age- and site-specific specialist care the proportion of overall care that was determined to be specialist, regardless of type of care, was calculated. The type of specialist care was assessed separately.

3.10 Variation in care pathways

Analysis of access to healthcare and geographical variation in care pathways was key to this project in order to examine how pathways alter nationally and to determine whether this was affected by access to specialist care. Variation in the levels of care received by patient and tumour demographics were assessed before geographical variation in access was investigated.

Firstly the proportion of patients within each cancer network (determined from the postcode of residence at diagnosis) who received the various levels of specialist care was assessed. Access to specialist care was then analysed using a network analysis and the catchment areas of known specialist centres were determined in an attempt to further understand the variation.

3.10.1 Patient demographics

The level and type of care received was assessed by age at diagnosis, gender and socioeconomic score for each diagnostic group individually. The proportion of patients within each group was compared for each demographic.

3.10.2 Diagnostic group

Differences in the level and type of specialist care received were analysed for the diagnostic subgroups of each Birch group (based on the morphology recorded at diagnosis). The proportion of patients receiving each level or type was compared for each subgroup within a Birch group.

3.10.3 Year of diagnosis

Variation in level and type of specialist care was compared for each year of diagnosis (2001-2006) by diagnostic group. The proportion of patients receiving each level or type was compared over time.

3.11 Geographical variation in specialist care

Several of the units were not open to accept patients throughout the entire time period covered by this study. Additionally the age ranges accepted by each unit also varied. In order to address this the unit closest to each patient was determined to be not only the closest centre geographically but the closest centre which was accepting patients at the time of admission and which had a suitable age range, in line with the restrictions described in Table 7.

3.11.1 Access to specialist centres

In order to assess access to healthcare and how the journey of patients was affected by the centralisation of cancer services it was necessary to know not only the Euclidean (crow-fly) distance from residence to hospital but also the road travel distance and time. Alongside this it is also important to establish whether the patient was travelling beyond the closest hospital with the potential to treat them to a multi-regional (tertiary) centre.

The postcodes of the address at the time of admission and all acute hospital sites in England were converted into national grid eastings and northings using GeoConvert. GeoConvert is undertaken at the Census Dissemination Unit at the University of Manchester and can be used to derive postcode metadata from the National Statistics Postcode Directory (NSPD) (Mimas, 2011). Eastings and northings form a 2D Cartesian system and are used to locate a position in reference to a map. This does not take into account the curvature of the earth but this will have a limited effect over relatively short distances.

GeoConvert does not convert into latitude and longitude which does allow for the spheroid shape of the globe but this conversion is not as readily available and is not linked to the NSPD. For this reason latitude and longitude were used only where eastings and northings were not available (i.e. the Channel Isles and the Isle of Man which are outside the Ordnance Survey of Great Britain (OSGB) grid and are instead on the World Geodetic System (WGS)84 grid.)

In order to address the geographical barriers affecting access to healthcare in more rural and remote areas it was decided to assess the road travel time and distance alongside the Euclidean distance from point to point. The ArcGIS road network analyst service was used to calculate the road travel time and distance between the address at admission and the hospital to which each patient was admitted.

The specialist centre each patient was admitted to was compared to the closest centre in terms of travel distance and the closest in terms of travel time. For those patients seen in a different trust the difference in travel distance and time between the hospital attended and the closest hospital was examined.

3.12 Geographical distribution of patients

The mapping of the catchment area of a hospital is complex, due to the small number of patients in some of the diagnostic groups in this study and the relatively small number of specialist centres it was decided to display the theoretical and actual catchment areas of each specialist centre using concentric circles representing travel distance.

For each cancer site the travel distance (km) from home to the nearest specialist centre was calculated for each patient. As previously described, the closest centre was the closest centre which was accepting patients of the age of the patient at the time of admission, rather than just the centre which was closest geographically. The specialist centre was used as the centre and a buffer zone containing 25%, 50% and 75% of patients was drawn according to the distance from home to the centre for each patient.

This was repeated to demonstrate actual travel distances using the same methodologies. This process meant it was possible to visually describe the catchment of each centre, both in theory and in practice.

3.12.1 Travel distance

Logistic regression modelling was used to calculate the effect of proximity to a specialist centre on the odds of admission to that specialist centre. Distance from registered home address to the closest centre, gender, age at diagnosis, deprivation score and diagnostic group were all modelled.

3.13 Patient outcomes

3.13.1 Treatment received

Information on surgery is well reported in the HES data, however both chemotherapy and radiotherapy data are known to be less accurate. In an attempt to address this, information held by the cancer registries on treatment was combined with that found in the HES data to produce an overall treatment variable. Major surgical resection was identified in the HES data using procedure codes (OPCS) which classified potential curative procedures for each cancer site. The codes were identified using a combination of those used in the NCIN major surgical resections report[247] and input from clinicians. Those used are listed in Appendix B – Classification of procedures**.**

The treatment received was compared across all levels of care for each diagnostic group. A variable which contained the following options was produced;

Surgery alone

Surgery and chemo/radiotherapy

Chemo/radiotherapy

No treatment recorded

3.13.2 Survival

Two different survival functions were calculated for each patient. Survival to the completion of the previously defined treatment period was calculated for each patient, each patient was either recorded as dead or alive at the end of the treatment period. Additional to this the survival to the end of the follow-up period was also calculated. Time between diagnosis and death was censored at three years from diagnosis to allow for the same follow up period for each patient.

3.13.2.1 Kaplan Meier

A Kaplan-Meier survival analysis was performed on the data to produce a nonparametric estimation of the survivor function. Three-year survival was assessed by level of specialist input, type of specialist input, diagnostic group and, where applicable, stage.

3.13.2.2 Cox modelling

Cox's proportional hazards model allows multivariate testing of explanatory variables to establish which, if any, affect the hazard risk (in this case, death) for the patient groups[248-250]. It was selected for use here as the outcome being assessed in this case was survival. Multi-level modelling was fit for purpose due to the small numbers which would reduce the power of any analysis.

This model was used to examine the effect of variables including those analysed in the Kaplan-Meier analysis, allowing for other important aspects of care and patient characteristics. It was also used to evaluate the effect of specialist treatment and the effect of travelling for treatment, as opposed to treatment near to home.

3.13.2.2.1 Model selection

Model selection was based upon clinical significance and all models were tested to ensure that the proportional hazards assumptions were met[250 251]. This was tested using the proportional hazards test[250 252] and Schoenfeld residuals[253 254] in Stata[255]. The results of these tests were non-significant except in the case of lymphoma. When survival was modelled for Hodgkin's and non-Hodgkin's separately the proportional hazards assumption held and so separate models were included.

The variability in the quality of chemo/radiotherapy data meant that this was tested in detail prior to inclusion in the final models. In each case the inclusion of a treatment variable meant

that the proportional hazards assumption was not met and it was felt that this was due to data quality issues rather than a true effect. There was also the suggestion of a significant interaction between diagnostic group and treatment received and lack of power meant it was not possible to model each diagnostic subgroup separately. Due to this, treatment was not included in the final Cox regression models.

Interactions were tested and no significant interactions were discovered other than in the case of central nervous systems, where diagnostic group was found to be strongly correlated with tumour grade[251 256]. In this case the model was re-run including the two variables separately and the goodness of fit was tested by plotting the cumulative hazard against the Cox Snell Residuals[257]. It was found that model fit was improved by the exclusion of diagnostic group and the inclusion of tumour grade.

Table 8: Summary of variables included in Cox regression models

Variables included in all analyses				
Variable	**Type**	**Description**		
Age	Continuous			
Year of diagnosis	Continuous			
Sex	Categorical	0	Male	**Reference category**
		1	Female	
Deprivation score	Categorical	1	Most deprived	**Reference category**
		2		
		3		
		4		
		5	Least deprived	
Diagnostic group	Categorical	See table detailing diagnostic information		
Level of specialist care	Categorical	1	Limited	**Reference category**
		2	Some	
		3	Mostly	
Additional variables				
Variable	**Type**	**Description**		
Type of specialist care	Categorical	1	Limited	**Reference category**
		2	Site specialist	
		3	Age specialist	
		4	Age and site specialist	
Tumour grade	Categorical	1	I	**Reference category**
		2	II	
		3	III	
		4	IV	
		5	Unknown	

3.13.2.2.2 Variables included in all models

A summary of the variables included in each model is presented in Chapter 4 and includes the proportion of patients seen in each group.

3.13.2.2.2.1 Age

The distribution of diagnostic subgroups within each Birch group is known to vary by age at diagnosis; the same can be said for admission to a specialist centre. Due to this, age at diagnosis was included as a continuous variable in the models for each diagnostic group.

The mean age at diagnosis varied between the diagnostic groups (Table 9), but, as expected was seen to fall around the middle of the age range.

Table 9: Mean age at diagnosis for each diagnostic group

Diagnostic group	Mean age at diagnosis
Leukaemia	19.3
Lymphoma	20.0
Central nervous system and other intracranial and intraspinal neoplasms	19.9
Osseous and chondromatous neoplasms, Ewing's sarcoma and other neoplasms of bone	19.1
Soft tissue sarcoma	20.0
Germ cell and trophoblastic neoplasms	21.0
Melanoma and skin carcinoma	21.1
Carcinomas	21.2
Overall	**20.4**

3.13.2.2.2.2 Sex

The gender of patients was modelled as a categorical variable (0- male, 1- female) and was included in the Cox model for each diagnostic group.

3.13.2.2.2.3 Year of diagnosis

Numerous guidelines for TYA cancers were released over the study period and this may have affected the 'gold standard' of care in place at the time. Consequently the year of diagnosis was included in each model, and was modelled as a continuous variable.

3.13.2.2.2.4 Deprivation score

There are known inequalities in the treatment of and survival from cancer between the most affluent and most deprived patients. In order to address these, the Index of Multiple Deprivation (IMD) score for each patient was included in the model.

The IMD score used for this project ranks lower super output areas (LSOA) according to household income. Scores were assigned to patients according to their LSOA of residence at the time of diagnosis according to postcodes.

3.13.2.2.2.5 Diagnostic group

Within each diagnostic group there are multiple subgroups. These are important as the subgroups may have differing prognosis and treatments. Consequently the subgroups of each Birch group were included in each model. In the majority of diagnostic groups the first subgroup was used as the reference category (Table 10), however in the case of soft tissue sarcoma and carcinomas too few deaths were observed in this group to fit the model. In order to address this an alternative group, with a higher number of events was chosen and the fit of the new model was tested in each case by assessing the Schoenfeld residuals and a proportional hazards test.

Table 10: Summary of diagnostic grouping variables included in Cox regression models

Diagnostic group	Description		
Leukaemia	1	Acute lymphoid leukaemia (ALL)	**Reference category**
	2	Acute myeloid leukaemia (AML)	
	3	Chronic myeloid leukaemia (CML)	
Lymphoma	1	Non-Hodgkin lymphoma (NHL)	**Modelled seperately**
	2	Hodgkin lymphoma (HL)	
Central nervous system and other intracranial and intraspinal neoplasms	1	Astrocytoma	**Excluded as tumour grade was included and found to be strongly corellated with diagnostic group**
	2	Other gliomas	
	3	Ependymomas	
	4	Medulloblastoma and other PNET	
	5	Other specified intracranial and intraspinal neoplasms	
	6	Unspecified intracranial and intraspinal neoplasms	
Osseous and chondromatous neoplasms, Ewing's sarcoma and other neoplasms of bone	1	Osteosarcoma	**Reference category**
	2	Ewing's sarcoma	
	3	Other	
Soft tissue sarcoma	1	Fibrosarcoma	
	2	Rhabdomyosarcoma	
	3	Other specified STS	**Reference category**
	4	Unspecified STS	
Germ cell and trophoblastic neoplasms	1	Germ cell and trophoblastic neoplasms	**Reference category**
	2	Germ cell and trophoblastic neoplasms of non-gonadal sites	
Melanoma and skin carcinoma	1	Melanoma	**Reference category**
	2	Skin carcinoma	
Carcinomas	1	Thyroid	
	2	Head and neck	
	3	Trachea, bronchus, lung and pleura	
	4	Breast	
	5	Genito-urinary tract	**Reference category**
	6	Gastro-intestinal tract	
	7	Other	

3.13.2.2.2.6 'Level' of specialist care

The level of specialist care received by each patient was determined by the proportion of their time as an inpatient which they spent at a specialist centre. Cox models were run using the proportion as a continuous variable and compared to models using the groups described previously (limited specialist input, some specialist input and mostly specialist care). In all cases the models were shown to have the best fit when including specialist input as a categorical variable.

3.13.2.2.3 Additional variables

3.13.2.2.3.1 Type of specialist care

The type of specialist care was only relevant for CNS and bone tumours and STS, where there were tumour specific specialist centres. Patients were grouped according to whether they had received;

Limited specialist input – less than 30% of care in a specialist centre

Site specific input – greater than 30% of care at a tumour specific centre, but less than 30% of time at a TCT centre

Age specific input – greater than 30% of care at a TCT centre, but less than 30% of time at a tumour specific centre

Age and site specific input – greater than 30% of care at a tumour specific centre and greater than 30% of care at a TCT centre.

This was included in the models for CNS and bone tumours and STS as a four-level categorical variable alongside the 'level' of care received.

3.13.2.2.3.2 Tumour grade

Stage is often used as a key prognostic factor; however it is poorly recorded for the majority of TYA tumour sites in cancer registration data. It was not possible to impute stage as it was missing in 99.93% of all cases. For brain and CNS tumours it was possible to calculate grade (I-IV or low to high) according to the World Health Organisation (WHO) classification of tumours[258 259], based on the morphology of the primary tumour. For brain and CNS tumours grade was entered into the model as a categorical variable, unfortunately this was not possible for any other tumour site.

3.13.3 Health service usage

Hospital service usage during treatment was compared across all groups of specialist attendees. The median number of admissions per patient was calculated for each group of specialist attendees. The median was used rather than the mean as the data were skewed and the median went some way to addressing this.

The proportion of the treatment period that each patient spent in hospital was calculated, censoring the follow up time at 18 months post diagnosis, unless a patient had died prior to this, in which case the date of death was used as the censor date. The length of hospital stay was divided by the length of follow up in order to determine the proportion spent as an inpatient.

Unplanned readmission to hospital has been used in several studies as a marker of the quality of care received and can, in some cases, be implicated in variation in outcomes[260-263]. Others have suggested that the variation in emergency readmission rates may be due to case mix and treatment variation[264]. Once the case mix between centres had been assessed it was possible to assess the variation in unplanned readmission between centre types, allowing for patient variation. The median proportion of all admissions occurring during the treatment period which were unplanned was compared across all groups of specialist attendee. The source of each admission was extracted from the HES data and any which was either not elective or maternity related was marked as an unplanned.

3.13.4 Health service costs

Health service costs were compared between groups of specialist attendees. These costs were calculated from the HES data using Healthcare Resource Groups (HRG's)[265]. HRG's are used to

classify data in order for costings for payment by results (PbR)[266] to be calculated. In this classification groups are assigned a cost for treatment which factors in length of stay, treatments received and certain patient demographic details. This process forms the basis of the NHS payment system, calculating the amount paid by commissioners to healthcare providers for each patient seen.

Information about each spell was grouped using the HRG "Local Grouper" which produced a code for each admission which was linked to a cost (which varied by year). Particularly complex or expensive admissions were further broken down and a code was provided for each episode within a spell, in these cases the cost for the entire admission was used.

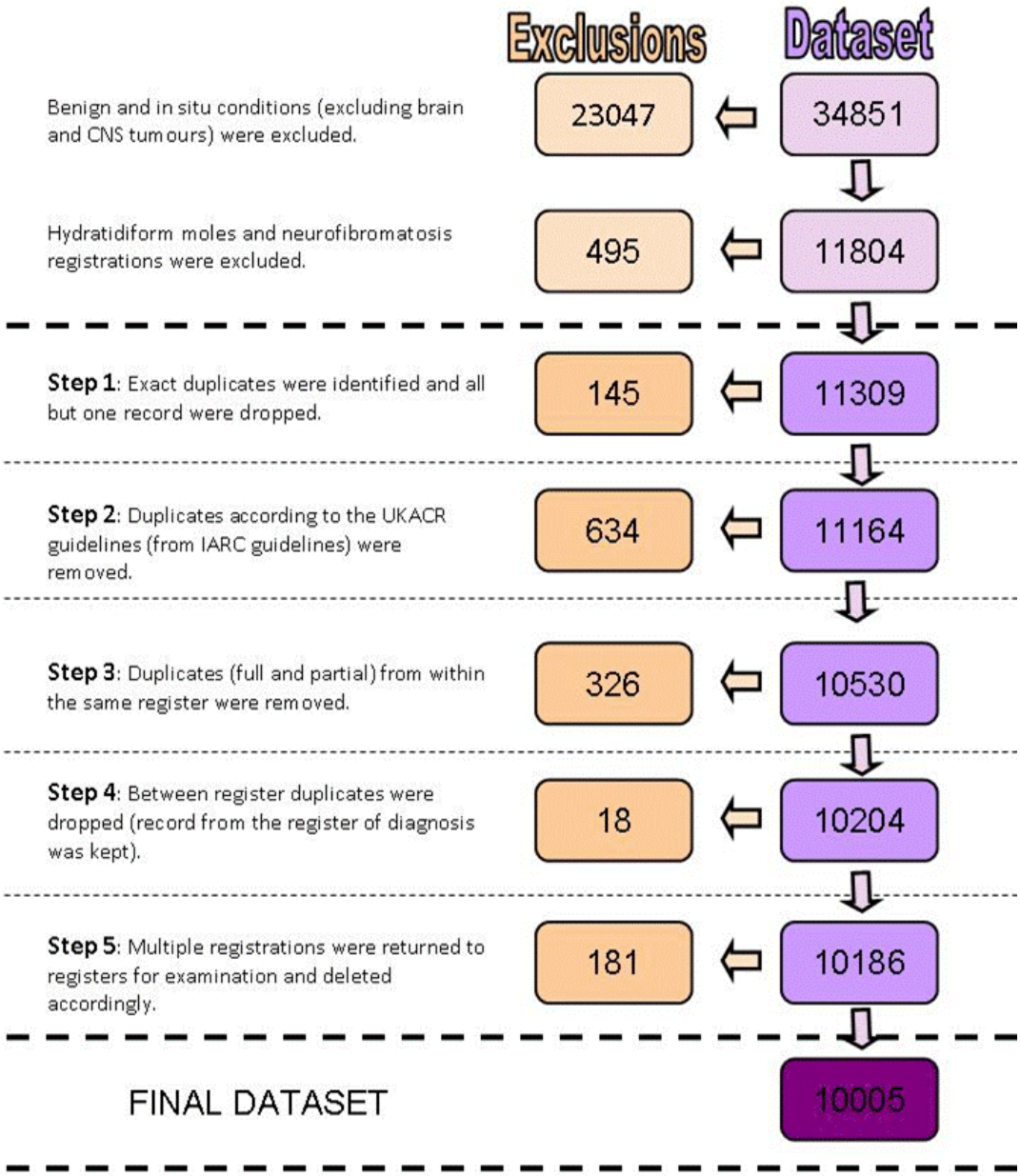
In this study the HRG group for each admission occurring within the treatment period was calculated and a cost assigned to each. The total cost per patient was then calculated and median costs compared between types of specialist attendees. It is important to acknowledge that these costs are for all admissions during the treatment period, regardless of the reason for admission, and so may not be cancer related. It also does not include the cost of outpatient care, and as such is not a 'complete' cost but is representative of the cost of inpatient care.

Chapter 4 Study population

This chapter details the results of the cleaning process and the demographics of both the patients in the cleaned dataset and those excluded due to non-linkage with the HES data. The demographics of the two subpopulations are compared in the following tables.

In total 24,846 tumours were excluded during the cleaning process, leaving 10,005 tumours. The number of cases removed at each stage of the data cleaning are presented in Figure 16.

Figure 16: Results of the deduplication process



Of the remaining 10,005 tumours 979 were either unclassified when using the Birch classification scheme or fell into groups nine and ten, miscellaneous or unspecified neoplasms.

Due to the wide range of disease types in these groups and the small number of patients in each these tumours were excluded from further study. This left a study population of 9,026 tumours.

Patients did not link to a HES record if they had no inpatient stay and therefore no hospital record, this was more likely in patients diagnosed with a melanoma or skin carcinoma than other diagnostic groups. Patients receiving supportive care only may also have been less likely to be admitted than their peers. Patients only appear in the extract of HES data if a diagnostic code for cancer was included in an admission, if this was not the case data would not have been received. Additionally patients may have failed to link to HES if the identifiers differed between the cancer registration and HES data.

The number of patients excluded due to a failure to link to HES data varied across England. In total 23.1% of those from the Oxford region were excluded compared to 11.4% from the Northern and Yorkshire region (Table 11). This reflects the geographical limitations of the data in that the registration of cancers is known to be variable with significant differences between regions. Whilst it was not possible to address this in this piece of work the variation was taken into consideration when analysing all results, in particular the access to healthcare work where the excluded cases may have biased the outcomes.

Table 11: Number of patients by cancer registry of residence

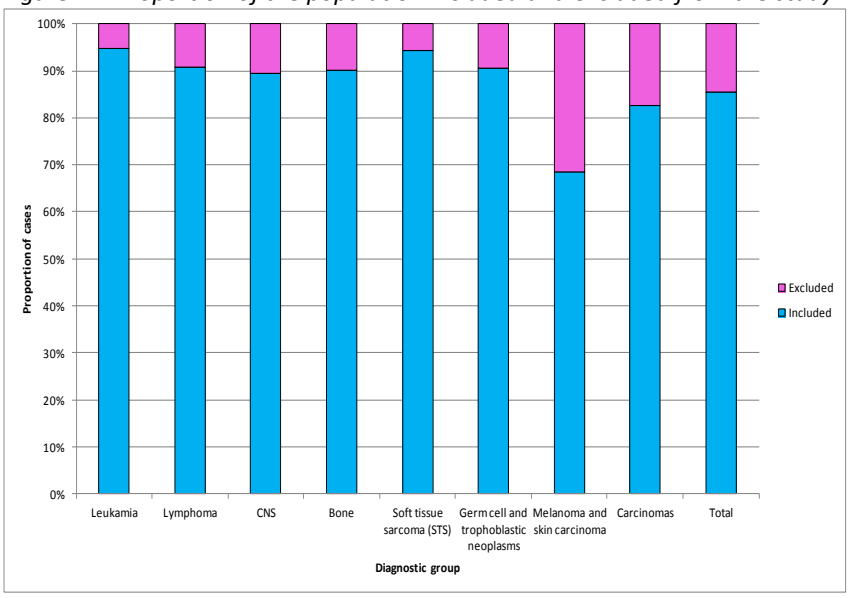
		Number of patients				
		Included		Excluded		
Registry name		n	%	n	%	Total
Northern and Yorkshire Cancer Registry	NYCRIS	1,326	88.6	171	11.4	1,497
West Midlands Cancer Intelligence Unit	WMCIU	807	86.6	125	13.4	932
South West Cancer Intelligence Service	SWCIS	1,173	87.0	175	13.0	1,348
North West Cancer Intelligence Service	NWCIS	1,087	84.4	201	15.6	1,288
Trent Cancer Registry	TRENT	712	83.3	143	16.7	855
Eastern Cancer Registration and Information Centre	ECRIC	721	87.9	99	12.1	820
Thames Cancer Registry	TCR	1,491	84.8	267	15.2	1,758
Oxford Cancer Intelligence Unit	OCIU	406	76.9	122	23.1	528
Total		**7723**	**85.6**	**1303**	**14.4**	**9,026**

In total 1,303 tumours were excluded from the study due to a lack of linkage to a HES record. This distribution of these exclusions over the eight diagnostic groups included in the study is shown in Figure 17 and Table 12. There is significant variation between the groups with approximately 5% of all leukaemia being excluded and over 30% of melanoma and skin carcinoma cases not linking to a HES record. This is representative of the variation in treatment modalities between the groups. Many melanoma and skin carcinoma patients are diagnosed after a biopsy and clear surgical resection margins on the biopsy would mean that further treatment was not necessary in the majority of cases. As a result there would be no inpatient stay, no HES record and consequently, no linkage.

Table 12: Number of patients in each diagnostic group

	Number of patients				
	Original dataset	Included		Excluded	
	n	n	%	n	%
Leukaemias	777	737	*94.9*	40	*5.1*
Lymphomas	1892	1716	*90.7*	176	*9.3*
Central Nervous system and other intracranial and intraspinal neoplasms	932	833	*89.4*	99	*10.6*
Osseous and chondromatous neoplasms, Ewing sarcoma and other neoplasms of bone	489	441	*90.2*	48	*9.8*
Soft tissue sarcomas	375	354	*94.4*	21	*5.6*
Germ cell and trophoblastic neoplasms	1331	1206	*90.6*	125	*9.4*
Melanoma and skin carcinoma	1635	1119	*68.4*	516	*31.6*
Carcinomas	1595	1317	*82.6*	278	*17.4*
Total	9026	7723	*85.6*	1303	*14.4*

Figure 17: Proportion of the population included and excluded from the study



In order to further examine the variation between those who were included and those who were excluded for each diagnostic group the patient demographic information for each group was compared. The results of this analysis are displayed in the following tables.

4.1 Leukaemia

777 TYA patients were diagnosed with leukaemia during the study period, of these 40 did not link to the HES data, meaning that there was no information on admission for these patients. The characteristics of the leukaemia population are shown in Table 13. Although few patients were excluded from the analysis it was possible to see that the age distribution varied between those included and those excluded. More of those excluded were from the older age group (aged 20-24 at diagnosis) than those who were included. The gender distribution also differed, with all but one (2.5%) of those excluded being male, in contrast 38% of those included were female. A higher proportion of those excluded were diagnosed with CML than was seen in those included, the distribution between the other diagnostic groups was similar. Additionally more of those who were excluded were from the most affluent quintile than was seen in those included in the study.

Table 13: The leukaemia population

		One or more admissions		No HES record		Total	
		n	%	n	%	n	%
Age at diagnosis	**15**	53	*7.2*	4	*10.0*	57	*7.3*
	16	97	*13.2*	4	*10.0*	101	*13.0*
	17	90	*12.2*	3	*7.5*	93	*12.0*
	18	81	*11.0*	1	*2.5*	82	*10.6*
	19	81	*11.0*	4	*10.0*	85	*10.9*
	20	80	*10.9*	5	*12.5*	85	*10.9*
	21	62	*8.4*	6	*15.0*	68	*8.8*
	22	64	*8.7*	2	*5.0*	66	*8.5*
	23	68	*9.2*	6	*15.0*	74	*9.5*
	24	61	*8.3*	5	*12.5*	66	*8.5*
Gender	**Male**	457	*62.0*	39	*97.5*	496	*63.8*
	Female	280	*38.0*	1	*2.5*	281	*36.2*
Year of diagnosis	**2001**	118	*16.0*	9	*22.5*	127	*16.3*
	2002	126	*17.1*	5	*12.5*	131	*16.9*
	2003	120	*16.3*	7	*17.5*	127	*16.3*
	2004	116	*15.7*	7	*17.5*	123	*15.8*
	2005	144	*19.5*	7	*17.5*	151	*19.4*
	2006	113	*15.3*	5	*12.5*	118	*15.2*
Diagnosis	**Acute Lymphoid Leukaemia (ALL)**	366	*49.7*	18	*45.0*	384	*49.4*
	Acute Myeloid Leukaemia (AML)	244	*33.1*	11	*27.5*	255	*32.8*
	Chronic Myeloid Leukaemia (CML)	93	*12.6*	9	*22.5*	102	*13.1*
	Other	34	*4.6*	2	*5.0*	36	*4.6*
Deprivation quintile	**5 (Most affluent)**	129	*17.5*	13	*32.5*	142	*18.3*
	4	125	*17.0*	6	*15.0*	131	*16.9*
	3	141	*19.1*	5	*12.5*	146	*18.8*
	2	151	*20.5*	8	*20.0*	159	*20.5*
	1 (Most deprived)	181	*24.6*	6	*15.0*	187	*24.1*
	Unknown	10	*1.4*	2	*5.0*	12	*1.5*
Total (number of patients)		**737**		**40**		**777**	

4.2 Lymphoma

1,892 TYA patients were diagnosed with lymphoma during the study period, of these 176 did not link to the HES data. The characteristics of the lymphoma population are shown in Table 14. As with the leukaemia population there was variation in distribution of patients across the demographic groups. Although there was variation seen in the age at diagnosis, gender and year of diagnosis the main differences were seen in the diagnostic groups and deprivation quintile. The most common diagnostic group in those included in the study was Hodgkin's lymphoma, accounting for 69% of all diagnoses. In contrast the most common diagnostic group in those excluded from the study was non-Hodgkin's lymphoma, which accounted for over half (51.1%) of all diagnoses in this group. This is disproportionately large and suggests that an additional factor is leading to this group not being admitted, such as a higher rate of outpatient treatment. The majority of those who were included in the study were from the most deprived quintile, whereas the majority of those excluded were from more affluent groups.

Table 14: The lymphoma population

		One or more admissions		No HES record		Total	
		n	%	n	%	n	%
Age at diagnosis	**15**	68	*4.0*	4	*2.3*	73	*3.9*
	16	164	*9.6*	7	*4.0*	171	*9.0*
	17	155	*9.0*	21	*11.9*	176	*9.3*
	18	150	*8.7*	14	*8.0*	164	*8.7*
	19	175	*10.2*	15	*8.5*	190	*10.0*
	20	194	*11.3*	23	*13.1*	217	*11.5*
	21	209	*12.2*	22	*12.5*	231	*12.2*
	22	205	*11.9*	21	*11.9*	226	*11.9*
	23	214	*12.5*	29	*16.5*	243	*12.8*
	24	182	*10.6*	20	*11.4*	202	*10.7*
Gender	**Male**	939	*54.7*	109	*61.9*	1,048	*55.4*
	Female	777	*45.3*	67	*38.1*	844	*44.6*
Year of diagnosis	**2001**	279	*16.3*	33	*18.8*	312	*16.5*
	2002	262	*15.3*	37	*21.0*	299	*15.8*
	2003	289	*16.8*	23	*13.1*	312	*16.5*
	2004	297	*17.3*	33	*18.8*	330	*17.4*
	2005	276	*16.1*	29	*16.5*	305	*16.1*
	2006	313	*18.2*	21	*11.9*	334	*17.7*
Diagnosis	**Non-Hodgkin lymphoma (NHL)**	532	*31.0*	90	*51.1*	622	*32.9*
	Hodgkin lymphoma (HL)	1,184	*69.0*	86	*48.9*	1,270	*67.1*
Deprivation quintile	**5 (Most affluent)**	332	*19.3*	42	*23.9*	374	*19.8*
	4	322	*18.8*	38	*21.6*	360	*19.0*
	3	321	*18.7*	29	*16.5*	350	*18.5*
	2	341	*19.9*	29	*16.5*	370	*19.6*
	1 (Most deprived)	383	*22.3*	34	*19.3*	417	*22.0*
	Unknown	17	*1.0*	4	*2.3*	21	*1.1*
Total (number of patients)		**1,716**		**176**		**1,892**	

4.3 Central nervous system and other intracranial and intraspinal neoplasms

932 TYA patients were diagnosed with a brain or CNS tumour during the study period, of these 99 did not link to the HES data. The characteristics of the brain and CNS tumour population are shown in Table 15. In contrast to both leukaemia and lymphoma very little variation was seen in the characteristics of those included and those excluded. There is a slight tendency towards those with unknown tumour grades being excluded and there was a peak in patients excluded in those diagnosed in 2002 and 2003. This lack of variation is suggestive that there was no single external factor affecting the likelihood of patients linking to a HES record.

Table 15: The CNS population

		One or more admissions		No HES record		Total	
		n	%	n	%	n	%
Age at diagnosis	**15**	43	*5.2*	2	*2.0*	45	*4.8*
	16	100	*12.0*	13	*13.1*	113	*12.1*
	17	74	*8.9*	6	*6.1*	80	*8.6*
	18	67	*8.0*	14	*14.1*	81	*8.7*
	19	84	*10.1*	9	*9.1*	93	*10.0*
	20	83	*10.0*	13	*13.1*	96	*10.3*
	21	78	*9.4*	10	*10.1*	88	*9.4*
	22	93	*11.2*	8	*8.1*	101	*10.8*
	23	96	*11.5*	11	*11.1*	107	*11.5*
	24	115	*13.8*	13	*13.1*	128	*13.7*
Gender	**Male**	444	*53.3*	55	*55.6*	499	*53.5*
	Female	389	*46.7*	44	*44.4*	433	*46.5*
Year of diagnosis	**2001**	110	*13.2*	16	*16.2*	126	*13.5*
	2002	141	*16.9*	20	*20.2*	161	*17.3*
	2003	138	*16.6*	23	*23.2*	161	*17.3*
	2004	135	*16.2*	14	*14.1*	149	*16.0*
	2005	168	*20.2*	12	*12.1*	180	*19.3*
	2006	141	*16.9*	14	*14.1*	155	*16.6*
Diagnosis	**Astrocytoma**	315	*37.8*	37	*37.4*	352	*37.8*
	Other gliomas	103	*12.4*	18	*18.2*	121	*13.0*
	Ependymoma	40	*4.8*	3	*3.0*	43	*4.6*
	Medulloblastoma and other PNET	56	*6.7*	7	*7.1*	63	*6.8*
	Other specified intracranial and intraspinal neoplasms	283	*34.0*	28	*28.3*	311	*33.4*
	Unspecified intracranial and intraspinal neoplasms	36	*4.3*	6	*6.1*	42	*4.5*
WHO grade of tumour	**I**	200	*24.0*	27	*27.3*	227	*24.4*
	II	256	*30.7*	35	*35.4*	291	*31.2*
	III	60	*7.2*	3	*3.0*	63	*6.8*
	IV	127	*15.2*	9	*9.1*	136	*14.6*
	Unknown	190	*22.8*	25	*25.3*	215	*23.1*
Deprivation quintile	**5 (Most affluent)**	152	*18.2*	17	*17.2*	169	*18.1*
	4	174	*20.9*	16	*16.2*	190	*20.4*
	3	158	*19.0*	13	*13.1*	171	*18.3*
	2	160	*19.2*	21	*21.2*	181	*19.4*
	1 (Most deprived)	181	*21.7*	26	*26.3*	207	*22.2*
	Unknown	8	*1.0*	6	*6.1*	14	*1.5*
Number of primary tumours	**1**	823	*98.8*	99	*100.0*	922	*98.9*
	2	10	*1.2*	0	*0.0*	10	*1.1*
	>2	0	*0.0*	0	*0.0*	0	*0.0*
	Total (number of patients)	**833**		**99**		**932**	

4.4 Osseous and chondromatous neoplasms, Ewing's sarcoma and other neoplasms of bone

489 TYA patients were diagnosed with a bone tumour during the study period, of these 48 did not link to the HES data. The characteristics of the bone tumour population are shown in Table 16. A greater proportion of those patients who were excluded from the study were diagnosed in 2002 and 2003 than those who were included. Whereas osteosarcoma was predominant in those who were included and Ewing's sarcoma was the second most common diagnostic group the opposite was true of those who were excluded. More of the patients who were excluded were from the most affluent groups, contrasting with what was seen in those patients who linked to a HES record. The age incidence patterns in both groups were erratic and showed little variation between those included and those excluded. As with other tumour groups there does not appear to be one single factor which defines those that did not have a HES record.

Table 16: The bone tumour population

		One or more admissions		No HES record		Total	
		n	%	n	%	n	%
Age at diagnosis	**15**	38	*8.6*	2	*4.2*	40	*8.2*
	16	60	*13.6*	3	*6.3*	63	*12.9*
	17	59	*13.4*	5	*10.4*	64	*13.1*
	18	59	*13.4*	9	*18.8*	68	*13.9*
	19	35	*7.9*	2	*4.2*	37	*7.6*
	20	38	*8.6*	6	*12.5*	44	*9.0*
	21	49	*11.1*	4	*8.3*	53	*10.8*
	22	41	*9.3*	5	*10.4*	46	*9.4*
	23	35	*7.9*	8	*16.7*	43	*8.8*
	24	27	*6.1*	4	*8.3*	31	*6.3*
Gender	**Male**	272	*61.7*	32	*66.7*	304	*62.2*
	Female	169	*38.3*	16	*33.3*	185	*37.8*
Year of diagnosis	**2001**	78	*17.7*	8	*16.7*	86	*17.6*
	2002	70	*15.9*	9	*18.8*	79	*16.2*
	2003	59	*13.4*	11	*22.9*	70	*14.3*
	2004	86	*19.5*	8	*16.7*	94	*19.2*
	2005	75	*17.0*	7	*14.6*	82	*16.8*
	2006	73	*16.6*	5	*10.4*	78	*16.0*
Diagnosis	**Osteosarcoma**	209	*47.4*	16	*33.3*	225	*46.0*
	Ewing's sarcoma	168	*38.1*	20	*41.7*	188	*38.4*
	Other	64	*14.5*	12	*25.0*	76	*15.5*
Deprivation quintile	**5 (Most affluent)**	81	*18.4*	10	*20.8*	91	*18.6*
	4	72	*16.3*	10	*20.8*	82	*16.8*
	3	73	*16.6*	7	*14.6*	80	*16.4*
	2	77	*17.5*	8	*16.7*	85	*17.4*
	1 (Most deprived)	116	*26.3*	11	*22.9*	127	*26.0*
	Unknown	22	*5.0*	2	*4.2*	24	*4.9*
Number of primary tumours	**1**	434	*98.4*	47	*97.9*	481	*98.4*
	2	7	*1.6*	1	*2.1*	8	*1.6*
	>2	0	*0.0*	0	*0.0*	0	*0.0*
Total (number of patients)		**441**		**48**		**489**	

4.5 Soft tissue sarcoma

375 TYA patients were diagnosed with a soft tissue sarcoma during the study period, of these 11 did not link to the HES data. The characteristics of the STS population are shown in Table 17. Very few STS patients failed to link to a HES record making the interpretation of differences between the groups difficult. The main difference was seen in the gender distribution between those included and those excluded from the study, with more of those included being male (53.8%). In the group that was excluded from the study only 36.4% were male.

Table 17: The soft tissue sarcoma population

		One or more admissions		No HES record		Total	
		n	%	n	%	n	%
Age at diagnosis	**15**	16	*4.4*	1	*9.1*	17	*4.5*
	16	38	*10.4*	1	*9.1*	39	*10.4*
	17	39	*10.7*	2	*18.2*	41	*10.9*
	18	32	*8.8*	1	*9.1*	33	*8.8*
	19	37	*10.2*	1	*9.1*	38	*10.1*
	20	29	*8.0*	0	*0.0*	29	*7.7*
	21	41	*11.3*	2	*18.2*	43	*11.5*
	22	41	*11.3*	0	*0.0*	41	*10.9*
	23	43	*11.8*	3	*27.3*	46	*12.3*
	24	48	*13.2*	0	*0.0*	48	*12.8*
Gender	**Male**	196	*53.8*	4	*36.4*	200	*53.3*
	Female	168	*46.2*	7	*63.6*	175	*46.7*
Year of diagnosis	**2001**	60	*16.5*	1	*9.1*	61	*16.3*
	2002	56	*15.4*	1	*9.1*	57	*15.2*
	2003	61	*16.8*	2	*18.2*	63	*16.8*
	2004	64	*17.6*	4	*36.4*	68	*18.1*
	2005	63	*17.3*	1	*9.1*	64	*17.1*
	2006	60	*16.5*	2	*18.2*	62	*16.5*
Diagnosis	**Fibrosarcoma**	68	*18.7*	3	*27.3*	71	*18.9*
	Rhabdomyosarcoma	81	*22.3*	1	*9.1*	82	*21.9*
	Other specified STS	153	*42.0*	5	*45.5*	158	*42.1*
	Unspecified	62	*17.0*	2	*18.2*	64	*17.1*
Deprivation quintile	**5 (Most affluent)**	50	*13.7*	0	*0.0*	50	*13.3*
	4	68	*18.7*	0	*0.0*	68	*18.1*
	3	74	*20.3*	0	*0.0*	74	*19.7*
	2	77	*21.2*	0	*0.0*	77	*20.5*
	1 (Most deprived)	87	*23.9*	0	*0.0*	87	*23.2*
	Unknown	8	*2.2*	11	*100.0*	19	*5.1*
Number of primary tumours	**1**	358	*98.4*	11	*100.0*	369	*98.4*
	2	6	*1.6*	0	*0.0*	6	*1.6*
	>2	0	*0.0*	0	*0.0*	0	*0.0*
Total (number of patients)		**364**		**11**		**375**	

4.6 Germ cell and trophoblastic neoplasms

1,331 TYA patients were diagnosed with a germ cell or trophoblastic neoplasm during the study period, of these 125 did not link to the HES data. The characteristics of the germ cell tumour population are shown in Table 18. The age distribution was broadly similar between those included and those excluded. In both groups the vast majority of patients were male, however there was a higher proportion of female patients in the excluded group than the included patients, this is reflected in the proportion of patients diagnosed with ovarian tumours in each group. The distribution of patients by both deprivation and year of diagnosis was very similar between the two groups. Again this suggests that no one single factor, such as increasing outpatient treatment, is influencing the proportion of patients linking to a HES record.

Table 18: The germ cell population

		One or more admissions		No HES record		Total	
		n	%	n	%	n	%
Age at diagnosis	**15**	20	*1.7*	3	*2.4*	23	*1.7*
	16	44	*3.6*	4	*3.2*	48	*3.6*
	17	70	*5.8*	6	*4.8*	76	*5.7*
	18	91	*7.5*	5	*4.0*	96	*7.2*
	19	110	*9.1*	12	*9.6*	122	*9.2*
	20	135	*11.2*	13	*10.4*	148	*11.1*
	21	156	*12.9*	15	*12.0*	171	*12.8*
	22	159	*13.2*	21	*16.8*	180	*13.5*
	23	205	*17.0*	17	*13.6*	222	*16.7*
	24	216	*17.9*	19	*15.2*	245	*18.4*
Gender	**Male**	1,092	*90.5*	104	*83.2*	1,196	*89.9*
	Female	114	*9.5*	21	*16.8*	135	*10.1*
Year of diagnosis	**2001**	183	*15.2*	31	*24.8*	214	*16.1*
	2002	185	*15.3*	19	*15.2*	204	*15.3*
	2003	202	*16.7*	22	*17.6*	224	*16.8*
	2004	202	*16.7*	23	*18.4*	225	*16.9*
	2005	229	*19.0*	16	*12.8*	245	*18.4*
	2006	205	*17.0*	14	*11.2*	219	*16.5*
Diagnosis	**Gonadal germ cell & trophoblastic neoplasms**	1,114	*92.4*	115	*92.0*	1,229	*92.3*
	Ovary	100	*9.0*	17	*14.8*	117	*9.5*
	Testis	1,014	*91.0*	98	*85.2*	1,112	*90.5*
	Germ cell & trophoblastic neoplasms of non-gonadal sites	92	*7.6*	10	*8.0*	102	*7.7*
Deprivation quintile	**5 (Most affluent)**	254	*21.1*	38	*30.4*	292	*21.9*
	4	234	*19.4*	26	*20.8*	260	*19.5*
	3	222	*18.4*	21	*16.8*	243	*18.3*
	2	247	*20.5*	21	*16.8*	268	*20.1*
	1 (Most deprived)	244	*20.2*	18	*14.4*	262	*19.7*
	Unknown	5	*0.4*	1	*0.8*	6	*0.5*
	Total (number of patients)	**1,206**		**125**		**1,331**	

4.7 Melanoma and skin carcinoma

1,635 TYA patients were diagnosed with melanoma or skin carcinoma during the study period, of these 516 did not link to the HES data. The characteristics of the melanoma and skin carcinoma population are shown in Table 19. The distribution of patients according to age at diagnosis, gender, year of diagnosis and deprivation was very similar between those excluded and those included. The major difference in this group is seen according to the diagnostic group. Patients with a HES record (and therefore one or more admission to hospital) had mostly been diagnosed with malignant melanoma (79.3%). In contrast only 54.5% of those without a HES record had been diagnosed with a malignant melanoma. Since the number of patients excluded in this group is so much larger than any other diagnostic group and more of the group who were excluded from the study had been diagnosed with a skin carcinoma, it can be suggested that this group are being treated out of the inpatient environment.

Table 19: The melanoma population

		One or more admissions		No HES record		Total	
		n	%	n	%	n	%
Age at diagnosis	**15**	23	*2.1*	6	*1.2*	29	*1.8*
	16	46	*4.1*	10	*1.9*	56	*3.4*
	17	53	*4.7*	24	*4.7*	77	*4.7*
	18	69	*6.2*	28	*5.4*	97	*5.9*
	19	87	*7.8*	40	*7.8*	127	*7.8*
	20	119	*10.6*	45	*8.7*	164	*10.0*
	21	147	*13.1*	72	*14.0*	219	*13.4*
	22	171	*15.3*	86	*16.7*	257	*15.7*
	23	187	*16.7*	87	*16.9*	274	*16.8*
	24	217	*19.4*	118	*22.9*	335	*20.5*
Gender	**Male**	390	*34.9*	188	*36.4*	578	*35.4*
	Female	729	*65.1*	328	*63.6*	1,057	*64.6*
Year of diagnosis	**2001**	188	*16.8*	68	*13.2*	256	*15.7*
	2002	190	*17.0*	77	*14.9*	267	*16.3*
	2003	175	*15.6*	71	*13.8*	246	*15.0*
	2004	171	*15.3*	101	*19.6*	272	*16.6*
	2005	215	*19.2*	97	*18.8*	312	*19.1*
	2006	180	*16.1*	102	*19.8*	282	*17.2*
Diagnosis	**Melanoma**	887	*79.3*	281	*54.5*	1,168	*71.4*
	Skin carcinoma	232	*20.7*	235	*45.5*	467	*28.6*
Deprivation quintile	**5 (Most affluent)**	231	*20.6*	136	*26.4*	367	*22.4*
	4	231	*20.6*	113	*21.9*	344	*21.0*
	3	218	*19.5*	91	*17.6*	309	*18.9*
	2	231	*20.6*	89	*17.2*	350	*21.4*
	1 (Most deprived)	198	*17.7*	76	*14.7*	274	*16.8*
	Unknown	10	*0.9*	11	*2.1*	21	*1.3*
Total (number of patients)		**1,119**		**516**		**1,635**	

4.8 Carcinomas

1,595 TYA patients were diagnosed with a carcinoma during the study period, of these 278 did not link to the HES data. The characteristics of the carcinoma population are shown in Table 20. The distribution of patients according to age, gender, year of diagnosis and deprivation was similar in those who were included in the study and those excluded. However the number of patients in each diagnostic group varied hugely. The second most common carcinoma in patients who were included in the study was carcinoma of the thyroid (26% of all cases), in contrast thyroid carcinoma accounted for only 12.9% of those excluded. The most common tumour site in both groups was the genitor-urinary (GU) tract, however the proportion that this accounts for differs between the groups (26.3% of those included versus 40.3% of those excluded). There was variation seen in all other diagnostic groups but it was not as significant as that seen in thyroid and GU carcinomas.

Table 20: The carcinoma population

		One or more admissions		No HES record		Total	
		n	%	n	%	n	%
Age at diagnosis	**15**	14	*1.1*	0	*0.0*	14	*0.9*
	16	62	*4.7*	19	*6.8*	81	*5.1*
	17	86	*6.5*	11	*4.0*	97	*6.1*
	18	76	*5.8*	10	*3.6*	86	*5.4*
	19	102	*7.7*	17	*6.1*	119	*7.5*
	20	120	*9.1*	29	*10.4*	149	*9.3*
	21	142	*10.8*	28	*10.1*	170	*10.7*
	22	185	*14.0*	38	*13.7*	223	*14.0*
	23	225	*17.1*	57	*20.5*	282	*17.7*
	24	305	*23.2*	69	*24.8*	374	*23.4*
Gender	**Male**	354	*26.9*	57	*20.5*	411	*25.8*
	Female	963	*73.1*	221	*79.5*	1,184	*74.2*
Year of diagnosis	**2001**	183	*13.9*	29	*10.4*	212	*13.3*
	2002	208	*15.8*	48	*17.3*	256	*16.1*
	2003	223	*16.9*	55	*19.8*	278	*17.4*
	2004	221	*16.8*	43	*15.5*	264	*16.6*
	2005	239	*18.1*	52	*18.7*	291	*18.2*
	2006	243	*18.5*	51	*18.3*	294	*18.4*
Diagnosis	**Thyroid**	343	*26.0*	36	*12.9*	379	*23.8*
	Head and neck	139	*10.6*	21	*7.6*	160	*10.0*
	Trachea, bronchus, lung & pleura	41	*3.1*	4	*1.4*	45	*2.8*
	Breast	74	*5.6*	3	*1.1*	77	*4.8*
	Genito-urinary tract	346	*26.3*	112	*40.3*	458	*28.7*
	Gastrointestinal tract	287	*21.8*	60	*21.6*	347	*21.8*
	Other	87	*6.6*	42	*15.1*	129	*8.1*
Deprivation quintile	**5 (Most affluent)**	215	*16.3*	52	*18.7*	627	*39.3*
	4	232	*17.6*	46	*16.5*	678	*42.5*
	3	234	*17.8*	59	*21.2*	693	*43.4*
	2	298	*22.6*	48	*17.3*	346	*21.7*
	1 (Most deprived)	332	*25.2*	63	*22.7*	395	*24.8*
	Unknown	6	*0.5*	10	*3.6*	16	*1.0*
Total (number of patients)		**1,317**		**278**		**1,595**	

4.9 Final study population

After all exclusions had been made the final number of patients to be included in the study was 7,733. The total number of patients by diagnostic group is shown in Table 21.

The proportion of patients excluded differed substantially between the eight diagnostic groups, being relatively low in leukaemia, lymphoma, CNS and bone tumours, STS and carcinoma. In contrast a much larger proportion of the germ cell, melanoma and skin carcinoma population was excluded due to non-linkage with HES data. The nature of the treatment pathways for both of these tumour groups means that these patients may be more likely to be treated as outpatients and less likely to require admission to hospital for either treatment or treatment related complications.

Table 21: The study population

Diagnostic group		Number of patients
Group 1	*Leukaemias*	**737**
Group 2	*Lymphomas*	**1,716**
Group 3	*Central Nervous system and other intracranial and intraspinal neoplasms*	**833**
Group 4	*Osseous and chondromatous neoplasms, Ewing sarcoma and other neoplasms of bone*	**441**
Group 5	*Soft tissue sarcomas*	**364**
Group 6	*Germ cell and trophoblastic neoplasms*	**1,206**
Group 7	*Melanoma and skin carcinoma*	**1,119**
Group 8	*Carcinomas*	**1,317**
Total		**7,733**

The following chapters present the results of the analyses undertaken as part of this study. The results of the attitudes to specialist care are presented first (Chapter 5), followed by the analyses for each of the different TYA cancers by diagnostic group:

Chapter 6- Leukaemia

Chapter 7- Lymphoma

Chapter 8- Central nervous system and other intracranial and intraspinal neoplasms

Chapter 9- Osseous and chondromatous neoplasms, Ewing's sarcoma and other neoplasms of bone

Chapter 10– Soft tissue sarcoma

Chapter 11 – Germ cell and trophoblastic neoplasms

Chapter 12 – Melanoma and skin carcinoma

Chapter 13 - Carcinomas

Within each chapter there are three key sections examining access to specialist care, variation in patient characteristics by the level of specialist care received and patient outcomes.

One factor thought to influence the uptake of specialist care is access to a centre and so this was examined using the proximity to a specialist centre from a patient's address at diagnosis. The access to specialist care was further assessed by analysing the proportion of patients in each cancer network receiving each level of care (limited, some or mostly specialist care). High

volume centres were identified for each cancer site, both in terms of number of patients and number of admissions. The results are presented in the first subchapter for each diagnostic group.

The characteristics of the tumour population were assessed according to the level of care received and the differences between the levels of care received both overall and for each diagnostic group individually. The results are presented in the second subchapter for each diagnostic group.

Multiple patient outcomes were assessed according to the level of care received for each diagnostic group. The results are detailed in the third subchapter for each diagnostic group. Treatment received, survival, health service usage and health service costs were all analysed in order to determine whether each outcome was affected by the level of specialist care received.

Chapter 5 Survey of attitudes to specialist care

In order to establish the degree to which attitudes towards specialist care varied between professionals involved in the diagnosis and treatment of TYA patients a survey of medical professionals was undertaken. This was used to assess to what extent opinions differed and whether there was a significant variation which could influence referral to and uptake of specialist services.

In total 691 healthcare professionals from 98 NHS Trusts were asked to complete the questionnaire and were approached using email. Of these 338 (51.9%) responded. The responses to the questions asked were analysed and all statements were ranked in order of the proportion ranked four or higher. The results of the ranking process are presented in Table 22.

When the questions were ranked in order of importance the three questions ranked most highly were:

- Contact with a nurse specialising in the care of TYA (94.6% marked as a 4 or higher)
- Psychological and psychosocial support from those specialising in the care of TYA (94.3% marked as a 4 or higher)
- Access to fertility specialists and advice on reproductive issues (93.7% marked as a 4 or higher)

The three statements ranked the lowest were:

- Diagnostics and staging by clinical teams specialising in the care of TYA (radiology, pathology etc.) (58.6% marked as a 4 or higher)
- Treatment at a hospital in close proximity to a patient's home address. (39.0% marked as a 4 or higher)
- Inpatient treatment on a site specific ward (e.g. breast) (34.3% marked as a 4 or higher)

The three statements which ranked the lowest also had the greatest number of indifferent responses (scored 3 on the Likert scale). These results did not follow what was expected when assessing them alongside the protocols in place at the time of the survey, such as access to clinical trials, both age- and site- specific and treatment at a high volume centre. All three of these statements ranked around the middle of the table of ordered responses. Certain aspects of care which have been recorded as being important by patients[130], such as treatment close to home, ranked much lower on the scale than expected.

In order to establish whether there were unseen factors influencing the responses to the survey and to group respondents according to the similarity of their responses a latent cluster

analysis was performed. This was used to cluster the respondents according to the responses given and hence determine any underlying relationships which define the groups. The goodness-of-fit test (Bayesian Information Criterion (BIC) scores) was used as a measure for model selection and was used to prevent 'over-fitting' by preferring a smaller number of parameters. For these data a three class model was selected. The patterns of responses are demonstrated in Figure 18. The three clusters had very different response patterns with cluster one rating age-appropriate treatment very highly in comparison to site-specific treatment. Cluster two rated most points high on the scale and didn't show a preference towards either age- or site-specialist care. In contrast cluster three rated site- specific care higher than age-appropriate care, but did not rate any points as highly as the other two clusters.

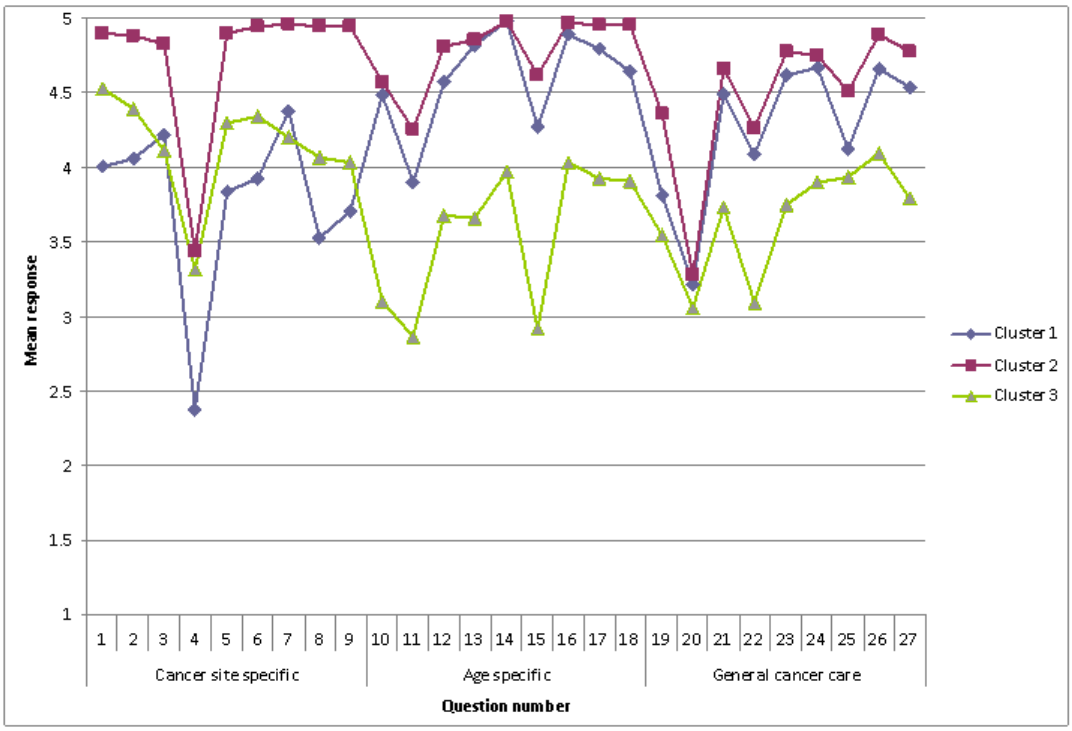
Overall it appeared that clusters should be grouped as follows;

Cluster 1 – Age-specific preference

Cluster 2 – Combined age- and site-specific preference

Cluster 3 – Cancer site-specific preference

Figure 18: Cluster analysis of the responses to the attitudes survey



The characteristics of the respondents are detailed in Table 23 and are compared across the three clusters which were identified during the cluster analysis. Overall 190 (56.2%) reported that they were affiliated with a teenage cancer unit and 208 (61.5%) were linked to a Children's Cancer and Leukaemia Group CCLG unit. The majority of respondents belonged to a medical rather than a surgical specialism (271 versus 67 respectively). Many respondents

additionally recorded that the patient range should not be restricted by age but by socioeconomic group and emotional maturity of the patient.

On further examination of the self-reported interests of the respondents (Table 23), the distribution of those affiliated with a TCT or CCLG unit was found to be even across the three clusters. Overall 99 of the doctors who responded (42.3%) fell into cluster one. Over half of all nurses (56.3%) were in cluster two.

The majority, 40.1%, of those specialising in oncology were in cluster one (57 respondents). Those specialising in haematology and paediatrics were seen more frequently in cluster one (60.0% and 55.6% of respondents), gynaecology and palliative care were seen mostly in cluster two (55.6% and 66.7% respectively).

A greater proportion of those reporting a site-specific interest, 201 persons in total, were identified as being in cluster one than any other cluster (39.3%). Those reporting an interest in both age- and site-specific care were mainly seen in cluster two, while the majority of those with an age-specific interest, 49 respondents in total, were in cluster three (51.0%).

Of those who reported an affiliation with a TCT centre the majority, 43.7%, were identified as being in cluster two. The majority of those recording no affiliation were found to belong in cluster one.

The majority of individuals with a low annual TYA workload (<11 cases or <10% of the annual caseload) were identified in cluster one. Those with a high workload (>15 cases or >30% of the annual caseload) were seen in cluster two.

These characteristics reflect what would be expected when comparing them to the clustered responses to the survey. Cluster two, who demonstrated both an age- and site-specific interest, had the highest TYA workload and the greater proportion of those affiliated to a TCT unit. Cluster one, who ranked age-appropriate care above site-specific, had the lowest TYA workload and had the lowest proportion of those reporting affiliation to a TCT centre. Despite their low involvement with TYA in comparison to other clusters they had the highest proportion of paediatric specialists, suggesting that their age-specific interest was related to age groups other than TYA patients. Cluster three, who reported a preference for site-specialist care contained a large proportion of those with a surgical speciality (35.8%) and therefore may have had a tendency to focus on the importance of site specific care.

Table 22: Responses to the attitudes survey

Statement number		Percentage responses: 4 or higher		3		2 or lower	Question
14	*	94.6		3.0		0.5	Contact with a nurse specialising in the care of teenagers and young adults
16	*	94.3		3.3		0.5	Psychological and psychosocial support from those specialising in the care of teenagers and young adults
26	*	93.7		4.9		0.5	Access to fertility specialists and advice on reproductive issues
7	*	92.4		4.8		0.7	Psychological and psychosocial support from those specialising in the care of persons with cancer
17	*	91.7		5.9		0.5	Access to age appropriate palliative care if needed
13		90.7		5.4		0.8	Treatment in an age appropriate environment
24		90.3		7.8		0.7	Support for family, friends and partners of the patient
18		89.3		7.3	*	3.0	Access to age appropriate end of treatment care and support and information on late effects of treatment
23		88.8		8.7		0.7	Educational and employment support during treatment
27		87.3		8.3		1.9	Ability to stay in contact with peers when in hospital
1		86.5		9.6		0.9	Treatment by a site specific surgical or medical team
21		86.1		12.1		0.5	Contact with peers who have undergone or are undergoing similar treatments
12		85.9		10.2		0.9	Access to age appropriate clinical trials
6		85.6		11.4		0.6	Regular follow up by a site specific MDT
5		85.1		9.6		1.3	Contact with a site specific clinical nurse specialist or Macmillan nurse
3		84.8		11.6		0.9	Access to site specific clinical trials
2		84.4		11.7		0.9	Diagnostics and staging by site specialist clinical teams (radiology, pathology etc)
25		80.7		14.5		2.1	Treatment by the same team throughout
9		80.4		13.4		2.5	Access to site specific end of treatment care and support and information on late effects of treatment
8		77.3		14.5	*	3.0	Access to site specific palliative care if needed
10		76.6		13.2		2.2	Treatment by a medical or surgical team who specialise in the treatment and care of teenagers and young adults
15		71.1		17.2		2.4	Regular follow up by an age specific MDT
19		69.5	*	22.4		1.6	Treatment at a high volume cancer centre
22		68.4	*	20.9	*	3.8	Outpatient appointments held in an age appropriate environment
11		58.6	*	25.8	*	3.1	Diagnostics and staging by clinical teams specialising in the care of TYA (radiology, pathology etc)
20		39.0	*	35.0	*	6.4	Treatment at a hospital in close proximity to a patients home address
4		34.3	*	27.1	*	7.6	Inpatient treatment on a site specific ward (e.g.. Breast)

An asterix (*) marks the 5 statements with the highest number of respondents marking it as such in each category

Table 23: Characteristics of respondents to the attitudes survey

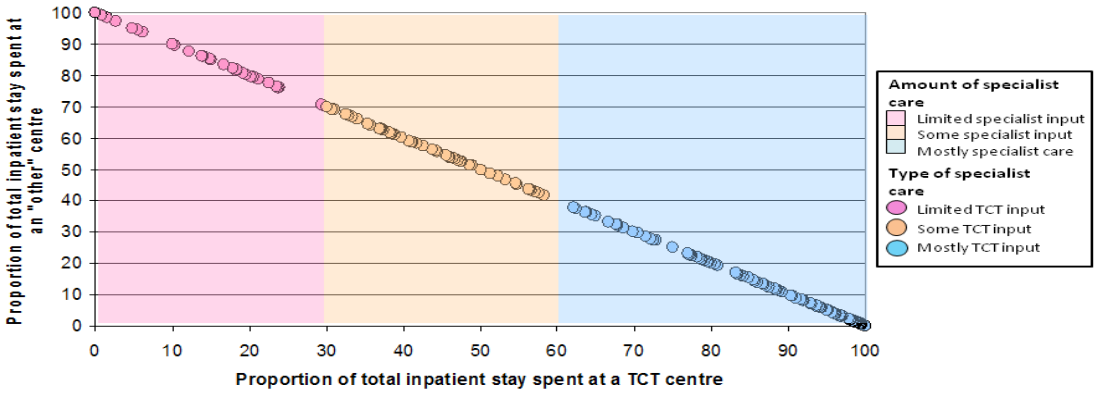
		Cluster 1		Cluster 2		Cluster 3		
		n	%	n	%	n	%	Total
Self reported job title	Doctor	99	42.3	69	29.5	66	28.2	234
	Nurse	9	14.1	36	56.3	19	29.7	64
	Radiographer	1	10.0	1	10.0	8	80.0	10
	Management	1	14.3	3	42.9	3	42.9	7
	Social worker	0	0.0	3	60.0	2	40.0	5
	Other	4	23.5	11	64.7	2	11.8	17
	Unknown	0	0.0	1	100.0	0	0.0	1
Specialism	Medical	92	33.9	103	38.0	76	28.0	271
	Surgical	22	32.8	21	31.3	24	35.8	67
Area of expertise	Oncology	38	26.8	57	40.1	47	33.1	142
	Haematology	27	60.0	13	28.9	5	11.1	45
	Paediatrics	10	55.6	1	5.6	7	38.9	18
	Gynaecology	2	11.1	10	55.6	6	33.3	18
	ENT	8	50.0	6	37.5	2	12.5	16
	Palliative medicine	4	26.7	10	66.7	1	6.7	15
	General surgery	3	21.4	4	28.6	7	50.0	14
	Radiology	0	0.0	3	30.0	7	70.0	10
	Other surgical speciality	18	35.0	2	15.0	15	45.0	35
	Other non surgical speciality	6	42.9	5	35.7	4	21.4	15
	Other	6	42.9	14	35.7	6	21.4	26
Type of specialist interest	Age	9	18.4	15	30.6	25	51.0	49
	Site	79	39.3	72	35.8	50	24.9	201
	Both	26	29.9	36	41.4	25	28.7	87
	Unknown	0	0.0	1	100.0	0	0.0	1
Teenage cancer unit	Yes	58	30.5	83	43.7	49	25.8	190
	No	56	37.8	41	27.7	51	34.5	148
CCLG unit	Yes	70	33.7	70	33.7	68	32.7	208
	No	44	33.8	54	41.5	32	24.6	130
Number of TYA patients seen annually	0 - 5	43	44.3	28	28.9	26	26.8	97
	6-10	25	52.1	10	20.8	13	27.1	48
	11-15	3	16.7	8	44.4	7	38.9	18
	16 - 20	3	27.3	5	45.5	3	27.3	11
	21+	3	8.6	17	48.6	15	42.9	35
	Unknown	37	28.7	56	43.4	36	27.9	129
Proportion of overall caseload consisting of TYA	Less than 10%	87	46.3	47	25.0	54	28.7	188
	10% - 20%	14	26.9	23	44.2	15	28.8	52
	20% - 30%	6	19.4	11	35.5	14	45.2	31
	30% - 40%	4	26.7	9	60.0	2	13.3	15
	Greater than 40%	3	6.0	32	64.0	15	30.0	50
	Unknown	0	0.0	2	100.0	0	0.0	2
Total		114	33.7	124	36.7	100	29.6	338

Chapter 6 Leukaemia

6.1 Specialist care

The proportion of total inpatient time during treatment spent at a specialist centre was compared to the time spent at any other type of hospital for leukaemia patients (Figure 19). Due to the form that leukaemia services take and the nature of the treatments for leukaemia, patients can be treated at many different centres and services are not centralised in the same way as those for some of the other diagnostic groups. This means that for leukaemia patients the proportion of treatment received at a TCT centre was compared to treatment at any other NHS facility.

Figure 19: Assignment of leukaemia patients to a "level" of specialist care using the proportion of inpatient time spent in a specialist centre



6.2 Access to specialist care

6.2.1 Hospital catchment areas

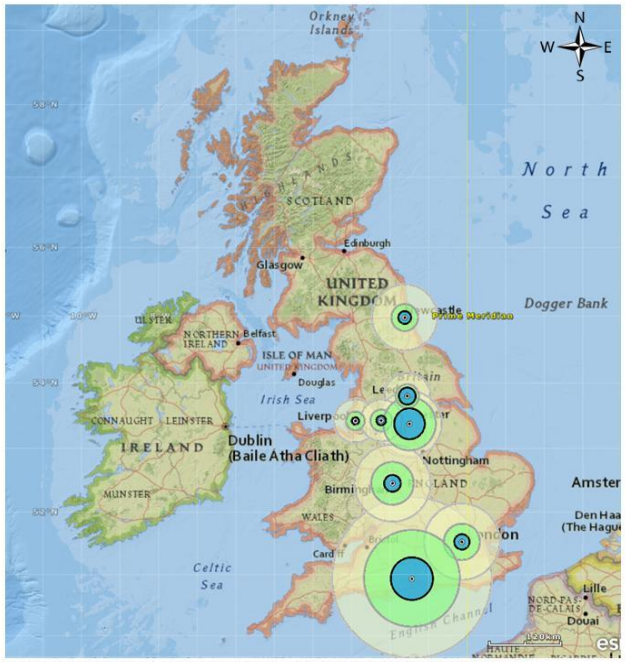
For each TCT centre the distance within which 25%, 50% and 75% of patients were found was mapped using concentric circles representing the distance from the patient's home address to both their closest centre (Map 7) and the centre to which they were admitted (Map 6). These maps display the real 'catchment area' for each centre alongside the actual geographical distribution of patients in relation to their closest specialist centre. As previously stated, the specialist centres for leukaemia were determined to be TCT centres and the location of all relevant centres are mapped in the methods.

The maps demonstrating the theoretical catchment areas of the TCT units treating leukaemia patients (Map 7) and the map demonstrating the actual catchment (Map 6) show a much

smaller catchment area and dispersion of patients admitted to Southampton, University College London Hospitals (UCL), Sheffield and Alder Hey. In contrast, Newcastle, Leeds, Birmingham and the Christie were attracting patients from outside their catchment area, as defined by proximity to the treating centre.

Alder Hey, UCL and Southampton also had the greatest proportion of patients, for whom they were the closest centre, who didn't attend any TCT unit during their treatment period. Newcastle and Leeds had, in reality, an increased catchment area compared to their theoretical coverage and they also had the smallest proportion of patients receiving no TCT input (11% and 22% respectively). Overall, for this diagnostic group, very few patients were admitted to a hospital other than their closest centre (Table 24). But the range of patients who were not admitted to a TCT unit during the treatment period varied widely across the country. For example, 83% of patients living closest to UCL had no admission to a TCT centre but, in contrast, only 11% of patients closest to Newcastle had no admission to a TCT centre. The number of patients closest to each centre also varied, reflecting the variation in population densities across England.

Map 7: Site of TCT centres in England (2001-2009) and the residential location of leukaemia patients closest to each centre



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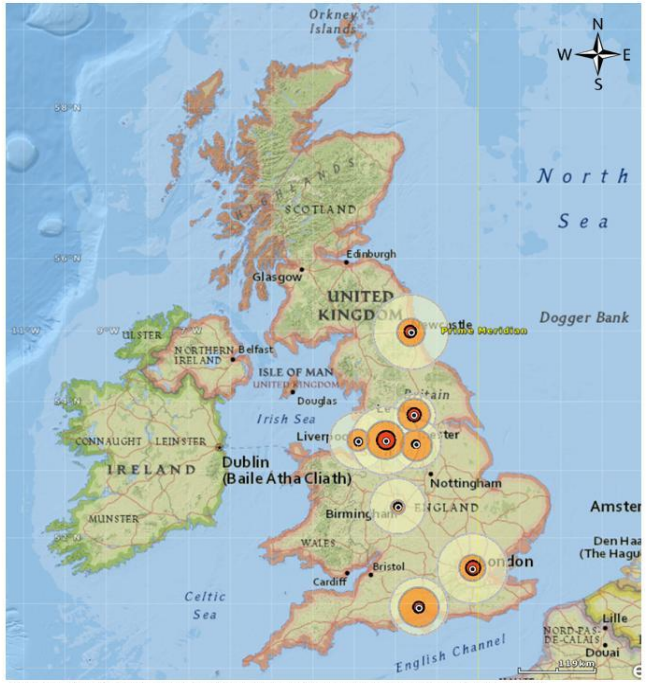
Key
- *Location of TCT centres*

Proportion of lymphoma patients
- *25% of cases*
- *50% of cases*
- *75% of cases*

Map 6: Site of TCT centres in England (2001-2009) and the residential location of leukaemia patients admitted to each



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Key
- *Location of TCT centres*

Proportion of lymphoma patients
- *25% of cases*
- *50% of cases*
- *75% of cases*

Table 24: Numbers of leukaemia patients closest to each TCT centre, and the centre actually attended

		NHS trust with a TCT unit to which the patient was admitted																		
		Alder Hey Children's NHS Foundation Trust		Leeds Teaching Hospitals NHS Trust		Sheffield Teaching Hospitals NHS Foundation Trust		University Hospital Southampton NHS Foundation Trust		The Christie NHS Foundation Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		University College London Hospitals NHS Foundation Trust		University Hospitals Birmingham NHS Foundation Trust		None		Total
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Closest NHS trust with a TCT unit at the time of admission	Alder Hey Children's NHS Foundation Trust	**4**	*13*	**0**	*0*	**0**	*0*	**0**	*0*	**2**	*6.5*	**0**	*0*	**0**	*0*	**0**	*0*	**25**	*81*	**31**
	Leeds Teaching Hospitals NHS Trust	**0**	*0*	**56**	*76*	**0**	*0*	**0**	*0*	**1**	*1.4*	**1**	*1.4*	**0**	*1.8*	**0**	*0*	**16**	*22*	**74**
	Sheffield Teaching Hospitals NHS Foundation Trust	**0**	*0*	**2**	*4.7*	**15**	*35*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**26**	*60*	**43**
	University Hospital Southampton NHS Foundation Trust	**0**	*0*	**2**	*1.5*	**2**	*1.5*	**32**	*24*	**0**	*0*	**1**	*0.7*	**3**	*0.5*	**2**	*1.5*	**94**	*69*	**136**
	The Christie NHS Foundation Trust	**0**	*0*	**1**	*1.2*	**0**	*0*	**0**	*0*	**26**	*32*	**0**	*0*	**0**	*0*	**6**	*7.4*	**48**	*59*	**81**
	The Newcastle upon Tyne Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**32**	*89*	**0**	*247*	**0**	*0*	**4**	*11*	**36**
	University College London Hospitals NHS Foundation Trust	**0**	*0*	**1**	*0.4*	**1**	*0.4*	**0**	*0*	**0**	*0*	**1**	*0.4*	**39**	*12*	**2**	*0.8*	**211**	*83*	**255**
	University Hospitals Birmingham NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**25**	*31*	**56**	*69*	**81**
	Total	**4**		**62**		**18**		**32**		**29**		**35**		**42**		**35**		**480**		**737**

Increasing road distance from a TCT centre decreased the odds of being admitted to a TCT centre during treatment for leukaemia patients (Odds Ratio (OR) 0.93 95% Confidence Intervals (CI) 0.91-0.96). For every 5km increase in distance between the patient's home address and the closest TCT centre there was a 7% decrease in the likelihood of admission to the centre.

A diagnosis of "other" leukaemia and CML (OR 0.48 and 0.67 respectively) and increasing age at diagnosis (OR 0.94) decreased the likelihood of admission to the closest TCT centre and were associated with a 52%, 33% and 6% decrease in the odds of admission to a TCT centre although these results did not reach statistical significance. In contrast a diagnosis of acute myeloid leukaemia increased the odds of admission to a TCT centre (OR 0.93) when compared to patients with ALL, these findings were not statistically significant (Table 25).

Table 25: Likelihood of admission to a TCT centre for leukaemia patients

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	1.02	0.92	0.71	1.47
Age at diagnosis		0.94	0.08	0.89	1.01
Diagnostic group	Acute lymphoid leukaemia	1.00			
	Acute myeloid leukaemia	1.31	0.18	0.89	1.94
	Chronic myeloid leukaemia	0.67	0.20	0.37	1.22
	Other	0.48	0.15	0.18	1.31
Deprivation	Most deprived	1.00			
	2	0.49	0.01	0.29	0.83
	3	0.95	0.86	0.57	1.60
	4	0.76	0.31	0.44	1.29
	Most affluent	0.65	0.11	0.39	1.10
Distance to nearest TCT centres (increase of 5km)		0.93	<0.01	0.91	0.96

6.2.2 Geographical distribution of patients

With the exception of patients resident in Lancashire and South Cumbria, Yorkshire, North Trent and North London, the majority of patients in all the English cancer networks received only limited care as an inpatient at a TCT centre (Table 26). This cannot be explained simply by the presence or absence of a TCT principal treatment centre within the network as only Yorkshire and North Trent had centres during the study period.

Table 26: Cancer network of residence at diagnosis and level of specialist inpatient care for leukaemia patients (highlighted sections represent the highest proportion of patients for each cancer network)

	Limited		Some TCT		Mostly TCT		Number of patients
	n	%	n	%	n	%	
Lancashire & South Cumbria	11	47.8	0	0.0	**12**	**52.2**	23
Greater Manchester & Cheshire	**43**	**75.4**	1	1.8	13	22.8	57
Merseyside & Cheshire	**22**	**88.0**	0	0.0	3	12.0	25
Yorkshire	23	35.9	5	7.8	**36**	**56.3**	64
Humber & Yorkshire Coast	**14**	**73.7**	3	15.8	2	10.5	19
North Trent	8	34.8	0	0.0	**15**	**65.2**	23
Pan Birmingham	**15**	**65.2**	3	13.0	5	21.7	23
Arden	**18**	**81.8**	3	13.6	1	4.5	22
Mid Trent	**12**	**100.0**	0	0.0	0	0.0	12
Derby/ Burton	**7**	**87.5**	0	0.0	1	12.5	8
Leicestershire, Northants & Rutland	**13**	**100.0**	0	0.0	0	0.0	13
Mount Vernon	**9**	**52.9**	1	5.9	7	41.2	17
West London	**11**	**73.3**	1	6.7	3	20.0	15
North London	8	44.4	0	0.0	**10**	**55.6**	18
North East London	**15**	**71.4**	0	0.0	6	28.6	21
South East London	**18**	**100.0**	0	0.0	0	0.0	18
South West London	**25**	**92.6**	0	0.0	2	7.4	27
Peninsula	**25**	**100.0**	0	0.0	0	0.0	25
Dorset	**13**	**92.9**	0	0.0	1	7.1	14
Avon, Somerset & Wiltshire	**37**	**100.0**	0	0.0	0	0.0	37
3 Counties	**5**	**71.4**	2	28.6	0	0.0	7
Thames Valley	**25**	**92.6**	1	3.7	1	3.7	27
Central South Coast	**28**	**100.0**	0	0.0	0	0.0	28
Surrey, West Sussex & Hampshire	**12**	**100.0**	0	0.0	0	0.0	12
Sussex	**17**	**94.4**	1	5.6	0	0.0	18
Kent & Medway	**33**	**97.1**	1	2.9	0	0.0	34
Greater Midlands	**17**	**70.8**	3	12.5	4	16.7	24
North of England	**37**	**100.0**	0	0.0	0	0.0	37
Anglia	**39**	**90.7**	1	2.3	3	7.0	43
Essex	**13**	**81.3**	0	0.0	3	18.8	16
Wales	**3**	**100.0**	0	0.0	0	0.0	3
Unknown	**5**	**71.4**	0	0.0	2	28.6	7
Total	581		26		130		737

6.2.3 High volume centres

The greatest number of leukaemia patients were admitted to the centre at Leeds(Table 27) the majority of admissions (1,966 admissions, 6.9% of all admissions) took place at the University Hospitals Bristol NHS Foundation Trust (Table 28). Of the 15 highest ranking NHS trusts, in terms of numbers of leukaemia patients, six were TCT centres and 10 were not (Table 27). Of the 15 highest ranking NHS trusts, in terms of admissions for leukaemia patients, five were TCT centres and 10 were not (Table 28). University Hospital Birmingham saw 4.9% of all TYA leukaemia patients but accounted for fewer than 2.1% of all admissions.

Table 27: Number of leukaemia patients admitted to each NHS trust during the treatment period (top 15 only)

Rank	NHS Trust	Number of patients n	%
1	Leeds Teaching Hospitals NHS Trust	61	*8.3*
2	Central Manchester University Hospital NHS Trust	52	*7.1*
3	University Hospitals Bristol NHS Foundation Trust	48	*6.5*
4	Cambridge University Hospitals NHS Foundation Trust	43	*5.8*
5	King's College Hospital NHS Foundation Trust	42	*5.7*
5	The Royal Marsden NHS Foundation Trust	42	*5.7*
5	University College London Hospitals NHS Trust	42	*5.7*
8	The Newcastle upon Tyne Hospitals NHS Trust	38	*5.2*
9	University Hospitals Birmingham NHS Foundation Trust	36	*4.9*
10	University Hospital of Southampton NHS Trust	32	*4.3*
11	Guy's & St Thomas's NHS Foundation Trust	29	*3.9*
11	The Christie NHS Foundation Trust	29	*3.9*
12	Barts and the London NHS Trust	27	*3.7*
12	Oxford Radcliffe Hospitals NHS Trust	27	*3.7*
14	Imperial College Healthcare NHS Trust	25	*3.4*
14	Nottingham University Hospitals NHS Trust	25	*3.4*
	Total number of patients	737	

TCT centre

Table 28: Number of admissions to each NHS trust during the treatment period, leukaemia patients

Rank	NHS Trust	Number of admissions n	%
1	University Hospitals Bristol NHS Foundation Trust	1,966	*6.9*
2	Central Manchester University Hospital NHS Trust	1,481	*5.2*
3	Cambridge University Hospitals NHS Foundation Trust	1,200	*4.2*
4	Leeds Teaching Hospitals NHS Trust	1,146	*4.0*
5	The Royal Marsden NHS Foundation Trust	1,122	*3.9*
6	The Christie NHS Foundation Trust	1,107	*3.9*
7	The Newcastle upon Tyne Hospitals NHS Trust	1,062	*3.7*
8	Oxford Radcliffe Hospitals NHS Trust	924	*3.2*
9	Barts and the London NHS Trust	892	*3.1*
10	University Hospital of Southampton NHS Trust	882	*3.1*
11	Royal Devon & Exeter NHS Foundation Trust	877	*3.1*
12	University College London Hospitals NHS Trust	781	*2.7*
13	Nottingham University Hospitals NHS Trust	774	*2.7*
14	University Hospitals Coventry & Warwickshire NHS Trust	688	*2.4*
15	King's College Hospital NHS Trust	597	*2.1*
	Total number of admissions	28,447	

TCT centre

6.3 Variation in the uptake of specialist care

The patient characteristics of the leukaemia patients vary by the amount of specialist care received as an inpatient (Table 29). The age distribution was roughly equal between those receiving some specialist input and those receiving mostly specialist care, with a greater

proportion of patients being in the younger age group (aged 15-19 at diagnosis). In contrast the patients with limited specialist input were mostly from the older age group (aged 20-24 at diagnosis). The gender distribution, deprivation score and proportion of patients alive at the completion of treatment were equal across all three groups. In all groups the majority of patients had a diagnosis of ALL; this group formed a larger proportion of the total group receiving some specialist input than in the other two groups. A significant variation in treatment received was seen across the three groups (p=<0.01). The majority of patients with limited specialist input were reported as having had chemotherapy alone (69.7%); the same was seen for patients for whom the majority of inpatient care was specialist, although this was a greater proportion (82.3%). For patients with some specialist input the most common treatment grouping was chemoradiotherapy (53.8%).

Table 29: Leukaemia patient details by amount of specialist inpatient care

		Type of specialist admissions							
		Limited		**Some TCT**		**Mostly TCT**			
		n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	241	*41.5*	14	*53.8*	66	*50.8*	321	
	20-24	340	*58.5*	12	*46.2*	64	*49.2*	416	*0.06*
Gender	**Male**	358	*61.6*	16	*61.5*	83	*63.8*	457	
	Female	223	*38.4*	10	*38.5*	47	*36.2*	280	*0.97*
Diagnostic group	**Acute Lymphoid Leukaemia (ALL)**	288	*49.6*	17	*65.4*	61	*46.9*	366	
	Acute Myeloid Leukaemia (AML)	188	*32.4*	7	*26.9*	49	*37.7*	244	
	Chronic Myeloid Leukaemia (CML)	76	*13.1*	2	*7.7*	15	*11.5*	93	
	Other	29	*5.0*	0	*0.0*	5	*3.8*	34	*0.94*
Deprivation	**Most affluent**	100	*17.2*	4	*15.4*	25	*19.2*	129	
	4	102	*17.6*	3	*11.5*	20	*15.4*	125	
	3	112	*19.3*	10	*38.5*	19	*14.6*	141	
	2	127	*21.9*	3	*11.5*	21	*16.2*	151	
	Most deprived	132	*22.7*	6	*23.1*	43	*33.1*	181	
	Unknown	8	*1.4*	0	*0.0*	2	*1.5*	10	*0.05*
Alive at end of treatment period	**Yes**	376	*64.7*	16	*61.5*	90	*69.2*	482	
	No	205	*35.3*	10	*38.5*	40	*30.8*	255	*0.52*
Treatment received	**Chemotherapy**	405	*69.7*	11	*42.3*	107	*82.3*	523	
	Radiotherapy	4	*0.7*	0	*0.0*	0	*0.0*	4	
	Chemoradiotherapy	116	*20.0*	14	*53.8*	16	*12.3*	156	
	None	56	*9.6*	1	*3.8*	7	*5.4*	64	*<0.01*
Total (number of patients)		581		26		130		737	

6.4 Patient outcomes

6.4.1 Treatment received

Outcomes for patients with leukaemia varied across the specialist care groups. Very few patients who received limited specialist input underwent radiotherapy, a small proportion underwent chemoradiotherapy but the majority received chemotherapy alone (Figure 20). For patients with some specialist inpatient input the dominant procedure was chemoradiotherapy (14 patients) with a slightly smaller group undergoing chemotherapy alone (11 patients). A different pattern was seen again in those with mostly specialist care, 82.3% of patients had chemotherapy alone. Across all groups the proportion of patients with no treatment recorded was low, with those having only limited specialist input having the highest proportion with no recorded treatment (>10%). The median time from diagnosis to both first admission and first chemotherapy (for eligible patients) was equal across all groups (Table 30).

Figure 20: Treatment received, by specialist group

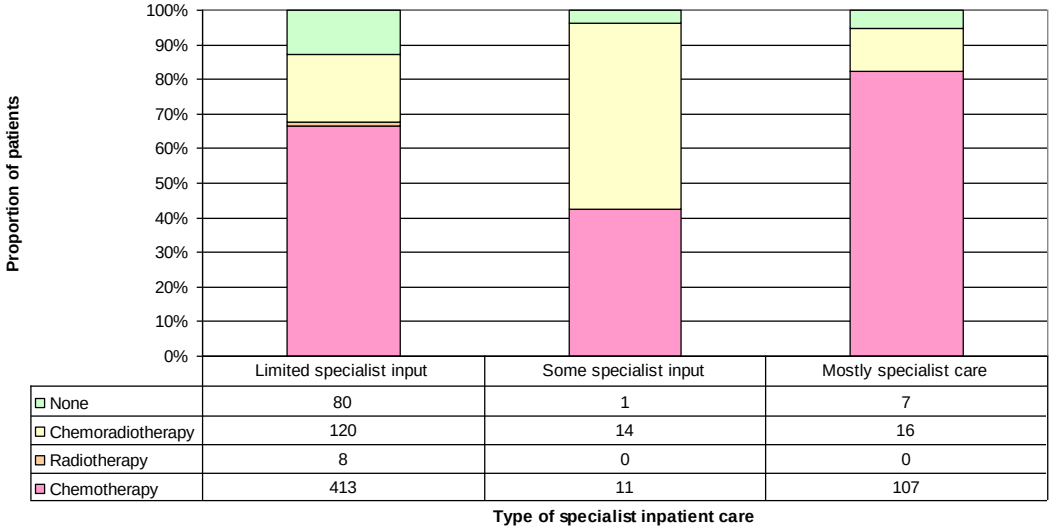


Table 30: Time from diagnosis to first admission and first treatment, by specialist group

	Weeks from diagnosis to first admission		Weeks fro diagnosis to first chemotherapy	
	Median	Range*	Median	Range*
Limited specialist input	0	-4 - 61	0	-4 - 149
Some specialist input	0	-2 - 0	0	-2 - 74
Mostly specialist care	0	-4 - 104	0	-4 - 119
* A negative value represents an event occuring before diagnosis				

6.4.2 Survival

The three-year survival for leukaemia patients was assessed by both diagnostic group and amount of specialist care received using Kaplan-Meier curves (Figure 21 & Figure 22). Overall those diagnosed with chronic myeloid leukaemia and those receiving mostly specialist care had the best survival with those diagnosed with acute myeloid leukaemia and “other” leukaemia and those with some specialist inpatient care having the poorest survival. Survival for those with limited specialist input fell in the middle of the three groups, supporting the suggestion that some of the patients in this group may have less aggressive disease than their counterparts in the other specialist care groups.

Figure 21: Survival to three years from diagnosis, by diagnostic subtype of leukaemia

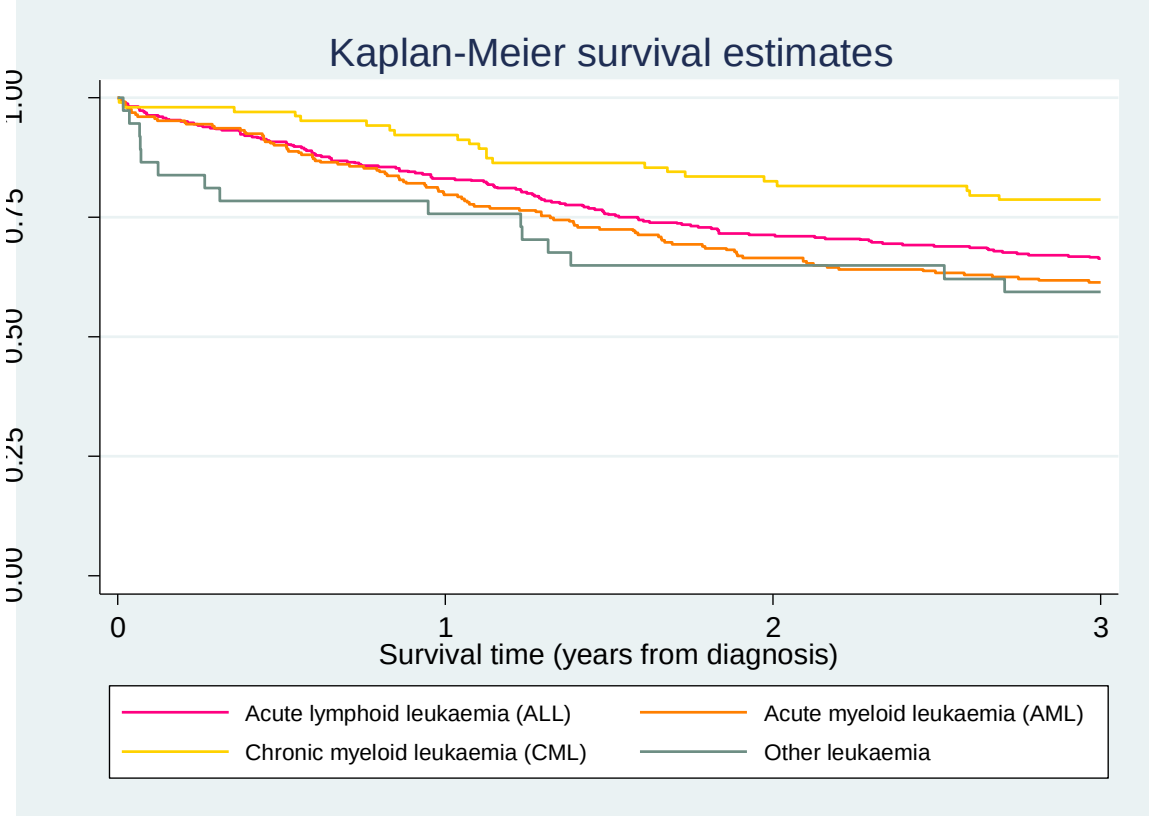
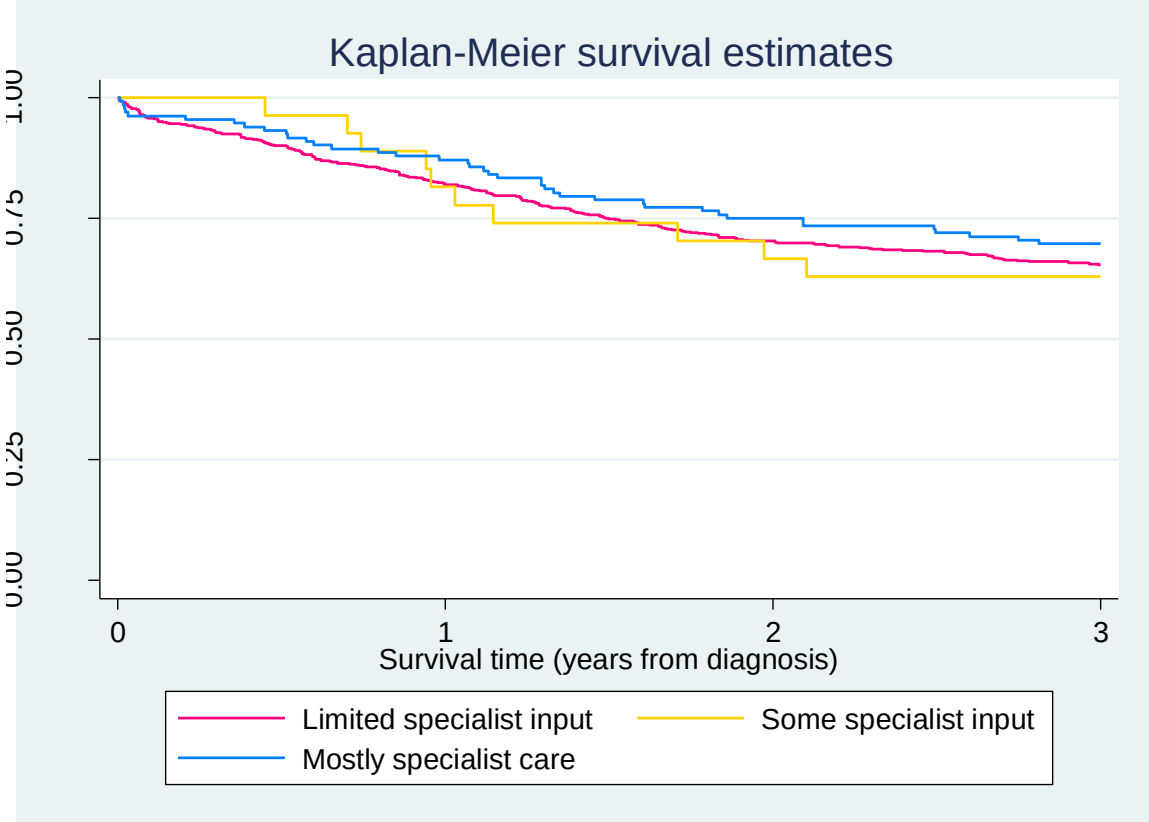


Figure 22: Survival to three years by amount to specialist care received, leukaemia patients



Proportional hazards were tested to determine whether the chosen Cox regression model could be applied. The results from this analysis are displayed in Table 31. The global test was non-significant (p=0.94) meaning that the proportional hazards assumption held and the Cox regression model could be used. There was no evidence that including age as a categorical variable improved fit and so it was included as a continuous variable in the model (p=0.20).

Table 31: Results of the proportional hazards test (stphtest)

		rho	χ2	prob> χ2
Age at diagnosis		0.08	1.66	*0.20*
Gender	**Male**	1.00		
	Female	-0.02	0.06	*0.80*
Year of diagnosis		-0.03	0.17	*0.68*
Deprivation	**1 (Most deprived)**	1.00		
	2	0.05	0.54	*0.46*
	3	0.04	0.34	*0.56*
	4	-0.01	0.04	*0.85*
	5 (Most affluent)	0.02	0.09	*0.77*
Diagnostic group	**ALL**	1.00		
	AML	-0.02	0.10	*0.75*
	CML	0.02	0.15	*0.70*
	Other	-0.08	1.57	*0.21*
Amount of specialist inpatient care	**Limited**	1.00		
	Some	0.04	0.32	*0.57*
	Mostly	0.03	0.28	*0.60*
Global test			5.57	*0.94*

In the Cox regression model (Table 32) only the diagnostic group had a statistically significant effect on survival, with those diagnosed with CML being 47% less likely to die than those diagnosed with ALL (Hazard Ratio (HR) 0.53 95%CI 0.33-0.85). Those receiving mostly specialist care were 17% more likely to survive than those with limited specialist input. Those with some specialist input were 16% more likely to die than those with limited specialist input but the trend was not statistically significant. Trends in relation to age at diagnosis, gender, deprivation group and year of diagnosis were also not statistically significant.

Table 32: Cox regression model for leukaemia

				Confidence intervals	
		Haz. Ratio	**p value**	**Lower 95%**	**Upper 95%**
Age at diagnosis		1.02	*0.30*	0.98	1.07
Gender	**Male**	1.00			
	Female	1.11	*0.41*	0.86	1.44
Year of diagnosis		0.94	*0.11*	0.88	1.01
Deprivation	**Most deprived**	1.00			
	2	0.87	*0.45*	0.60	1.25
	3	0.80	*0.25*	0.54	1.17
	4	0.83	*0.37*	0.56	1.24
	Most affluent	1.09	*0.65*	0.76	1.56
Diagnostic group	**ALL**	1.00			
	AML	1.14	*0.35*	0.87	1.50
	CML	0.53	*0.01*	0.33	0.85
	Other	1.37	*0.25*	0.80	2.35
Amount of specialist inpatient care	**Limited**	1.00			
	Some	1.16	*0.65*	0.61	2.21
	Mostly	0.83	*0.28*	0.58	1.17

6.4.3 Health service usage

As demonstrated in Figure 23 the peak in admissions for leukaemia patients occurred at the same time from diagnosis in all three specialist care groups. This is more pronounced in the group receiving limited specialist input as it contained the largest number of patients in total. Patients receiving some specialist inpatient care had the highest median number of admissions during treatment (Figure 24), the greatest proportion of unplanned admissions (Figure 25) and spent the largest percentage of the treatment period as inpatients (Figure 26). Those with limited specialist input and those receiving mostly specialist care had similar levels of admission during treatment and proportion of unplanned admissions (Figure 24 & Figure 25). Those receiving limited specialist input spent the least amount of the treatment period as an inpatient (Figure 26).

Figure 23: Number of admissions per week, by time from diagnosis and specialist group

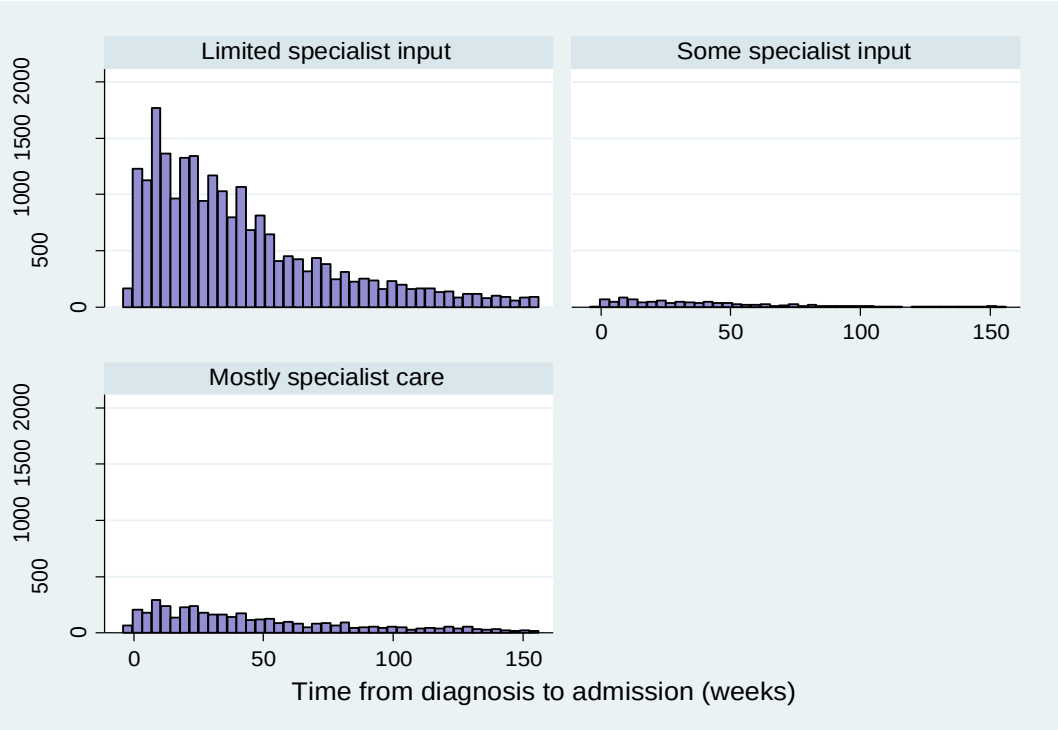


Figure 24: Median number of admissions per patient during treatment, by specialist group

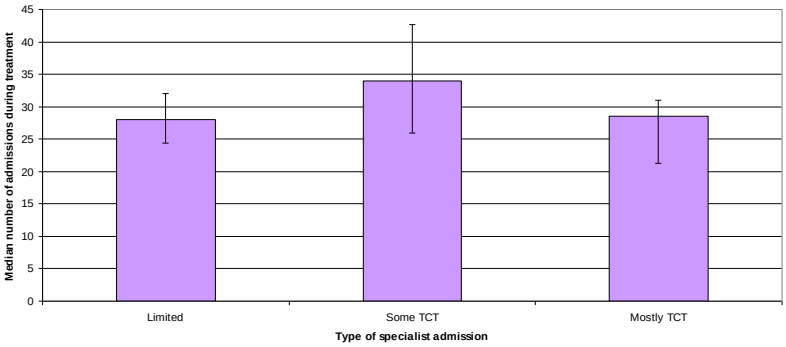


Figure 25: Median proportion of admissions, per patient, during treatment which were unplanned

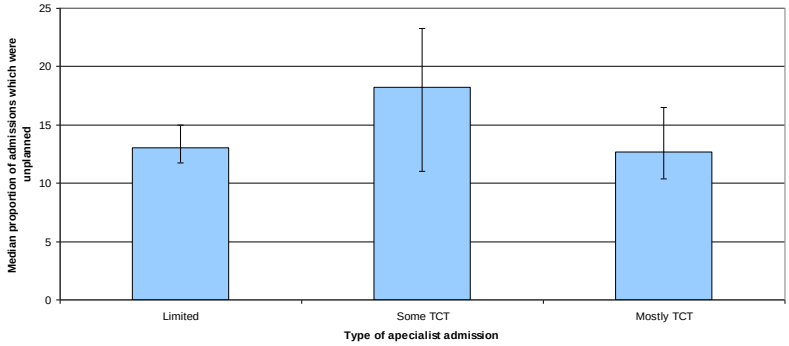
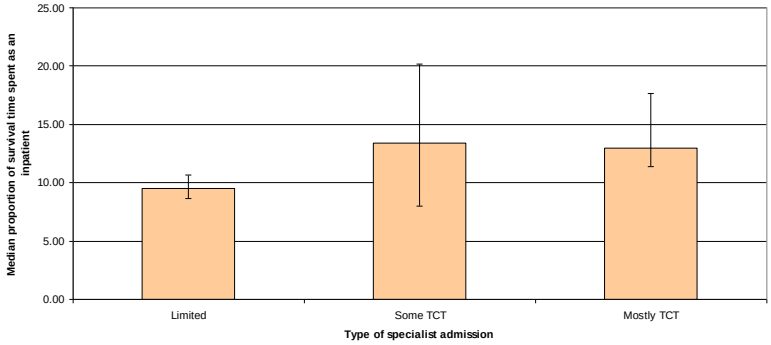


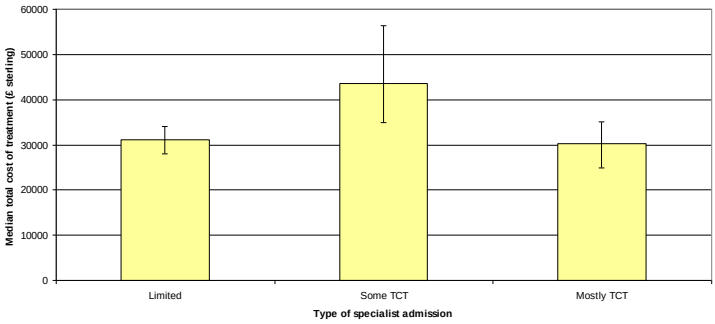
Figure 26: Median proportion of the treatment period spent as an inpatient, per patient



6.4.4 Health service costs

Overall patients with some specialist input had the highest median total cost of admissions during treatment (Figure 27), this will be influenced by the fact that they had the highest median number of admissions per patient, the greatest number of unplanned admissions and spent the largest proportion of the treatment period as an inpatient of any of the three specialist care groups. The median cost per admission for the specialist care groups was calculated to counteract this and there was no variation seen between groups in the median cost.

Figure 27: Median total cost of admissions during treatment, per patient

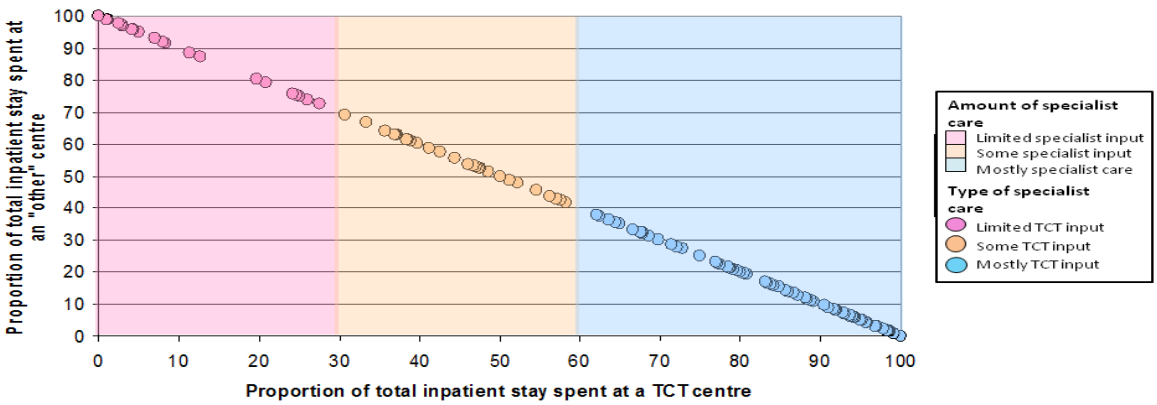


Chapter 7 Lymphoma

7.1 Specialist care

The proportion of total inpatient time during treatment spent at a specialist centre was compared to the time spent at any other type of hospital for lymphoma patients (Figure 28). As with leukaemia, the majority of lymphoma services (with the exception of bone-marrow transplantation) are not centralised in the same way as those for some of the other diagnostic groups. For lymphoma patients the proportion of treatment received at a TCT centre was, therefore, compared to treatment at any other NHS facility.

Figure 28: Assignment of lymphoma patients to a "level" of specialist care using the proportion of inpatient time spent in a specialist centre



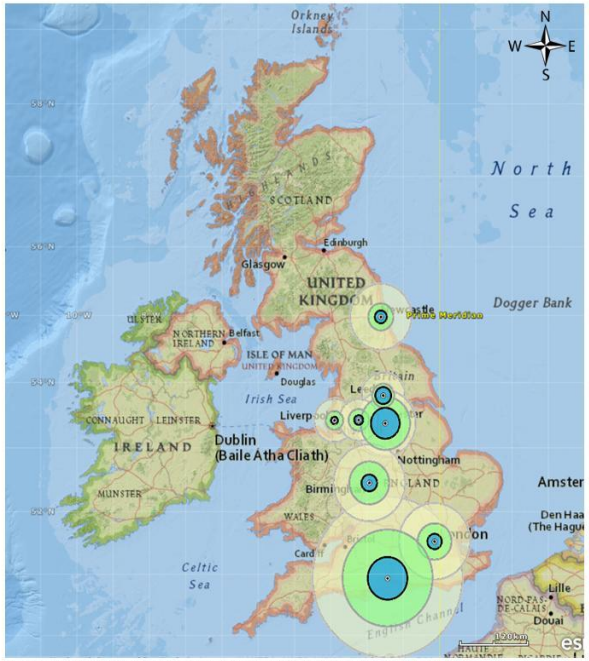
7.2 Access to specialist care

7.2.1 Hospital catchment areas

Due to the type of treatments used in lymphoma and the centralisation of services there were no high volume lymphoma centres in the same way that there were centres for other diagnostic groups (e.g. bone and CNS tumours). This lead to TCT centres being treated as the sole specialist centre for this group. With the exception of the Christie, Newcastle and Alder Hey all TCT centres showed a smaller dispersion of patients (Map 8) than theoretical catchment area (Map 9) suggesting that patients are admitted to hospitals other than their closest TCT centre. These three centres were shown to be attracting patients from outside their theoretical catchment areas, based on proximity to a specialist centre. As was seen with leukaemia patients, Alder Hey, Southampton and UCL had the greatest proportion of patients, for whom they were the closest centre, who didn't attend any TCT unit during their treatment period. In the case of lymphoma these three centres were joined by Birmingham, where 76.0%

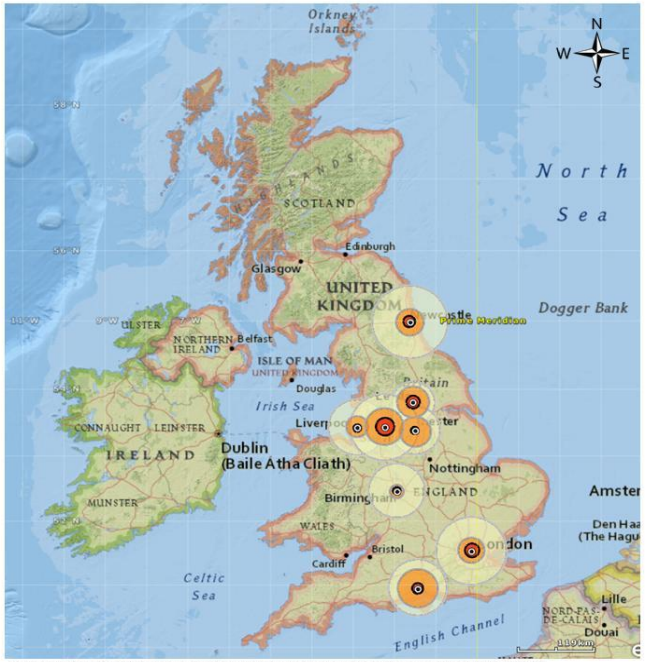
of patients who lived closest to this centre had no inpatient stays at a TCT centre during treatment. Newcastle and the Christie both had larger catchment areas in actuality than that which was predicted, and had some of the lowest levels of patients with no TCT admission during treatment (27.0% and 38.0% respectively). Leeds also had very few patients with no TCT admissions during treatment (34.0%). As with leukaemia, very few patients were admitted to a centre other than their closest one. With the exception of the Christie, who admitted 10 patients for whom Alder Hey was the closest unit (Table 33).

Map 9: Site of TCT centres in England (2001-2009) and the residential location of lymphoma patients closest to each centre



Key
- Location of TCT centres
- Proportion of lymphoma patients
  - 25% of cases
  - 50% of cases
  - 75% of cases

Map 8: Site of TCT centres in England (2001-2009) and the residential location of lymphoma patients admitted to each



Key
- Location of TCT centres
- Proportion of lymphoma patients
  - 25% of cases
  - 50% of cases
  - 75% of cases

Table 33: Numbers of lymphoma patients closest to each TCT centre, and the centre actually attended

		NHS trust with a TCT unit to which the patient was admitted																		
		Alder Hey Children's NHS Foundation Trust		Leeds Teaching Hospitals NHS Trust		Sheffield Teaching Hospitals NHS Foundation Trust		University Hospital Southampton NHS Foundation Trust		The Christie NHS Foundation Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		University College London Hospitals NHS Foundation Trust		University Hospitals Birmingham NHS Foundation Trust		None		Total
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Closest NHS trust with a TCT unit at the time of admission	Alder Hey Children's NHS Foundation Trust	**6**	*6.3*	**0**	*0*	**0**	*0*	**0**	*0*	**10**	*11*	**0**	*0*	**0**	*0*	**1**	*1.1*	**78**	*82*	**95**
	Leeds Teaching Hospitals NHS Trust	**0**	*0*	**68**	*56*	**1**	*0.8*	**0**	*0*	**3**	*2.5*	**1**	*0.8*	**0**	*0.7*	**0**	*0*	**49**	*40*	**122**
	Sheffield Teaching Hospitals NHS Foundation Trust	**0**	*0*	**2**	*1.6*	**34**	*27*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**91**	*72*	**127**
	University Hospital Southampton NHS Foundation Trust	**1**	*0.4*	**0**	*0*	**1**	*0.4*	**37**	*13*	**0**	*0*	**1**	*0.4*	**7**	*0.1*	**2**	*0.7*	**227**	*82*	**276**
	The Christie NHS Foundation Trust	**1**	*0.8*	**0**	*0*	**0**	*0*	**0**	*0*	**63**	*53*	**0**	*0*	**0**	*0*	**1**	*0.8*	**53**	*45*	**118**
	The Newcastle upon Tyne Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**1**	*1.3*	**0**	*0*	**0**	*0*	**50**	*64*	**0**	*82*	**0**	*0*	**27**	*35*	**78**
	University College London Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**2**	*0.3*	**1**	*0.2*	**2**	*0.3*	**2**	*0.3*	**78**	*12*	**1**	*0.2*	**567**	*87*	**653**
	University Hospitals Birmingham NHS Foundation Trust	**0**	*0*	**0**	*0*	**2**	*0.8*	**0**	*0*	**0**	*0*	**0**	*0*	**2**	*0*	**39**	*16*	**204**	*83*	**247**
	Total	**8**		**70**		**41**		**38**		**78**		**54**		**87**		**44**		**1296**		**1716**

As with leukaemia patients, increasing distance from the nearest TCT centre reduced the odds of admission to a TCT centre during treatment (Table 34). This trend was statistically significant and every 5km increase in distance between home and the closest TCT centre was associated with a 3% decrease in admission to the centre (OR 0.97 95%CI 0.96-0.98). Increasing deprivation, female gender and increasing age at diagnosis also decreased the odds of admission to a TCT centre but these were not statistically significant findings.

Table 34: Likelihood of admission to a TCT centre for lymphoma patients

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	0.84	0.07	0.70	1.02
Age at diagnosis		0.98	0.35	0.95	1.02
Diagnostic group	Non Hodgkins lymphoma	1.00			
	Hodgkins lymphoma	1.07	0.49	0.88	1.31
Deprivation	Most deprived	1.00			
	2	0.79	0.11	0.59	1.05
	3	0.96	0.79	0.72	1.29
	4	1.05	0.73	0.79	1.41
	Most affluent	1.18	0.26	0.89	1.57
Distance to nearest TCT centres (increase of 5km)		0.97	<0.01	0.96	0.98

7.2.2 Geographical distribution of patients

In seven of the 31 cancer networks the majority of patients received mostly specialist TCT inpatient care (greater than 60% of their total inpatient stay during treatment) (Table 35). This

again cannot be explained purely by the location of TCT centres and must instead be influenced by referral processes.

Table 35: Cancer network of residence at diagnosis and level of specialist inpatient care for lymphoma patients (the highlighted sections represent the most frequent level of care for each cancer network)

	Limited		Some TCT		Mostly TCT		Number of patients
	n	%	n	%	n	%	
Lancashire & South Cumbria	14	28.6	0	0.0	**35**	**71.4**	49
Greater Manchester & Cheshire	35	38.0	6	6.5	**51**	**55.4**	92
Merseyside & Cheshire	**44**	**62.9**	0	0.0	26	37.1	70
Yorkshire	36	35.0	4	3.9	**63**	**61.2**	103
Humber & Yorkshire Coast	**19**	**65.5**	2	6.9	8	27.6	29
North Trent	19	33.9	1	1.8	**36**	**64.3**	56
Pan Birmingham	35	48.6	1	1.4	**36**	**50.0**	72
Arden	**26**	**78.8**	1	3.0	6	18.2	33
Mid Trent	**42**	**72.4**	0	0.0	16	27.6	58
Derby/ Burton	**17**	**63.0**	0	0.0	10	37.0	27
Leicestershire, Northants & Rutland	**43**	**72.9**	0	0.0	16	27.1	59
Mount Vernon	**18**	**52.9**	0	0.0	16	47.1	34
West London	**32**	**57.1**	3	5.4	21	37.5	56
North London	19	39.6	5	10.4	**24**	**50.0**	48
North East London	**26**	**52.0**	0	0.0	24	48.0	50
South East London	**27**	**64.3**	1	2.4	14	33.3	42
South West London	**39**	**67.2**	0	0.0	19	32.8	58
Peninsula	**49**	**72.1**	0	0.0	19	27.9	68
Dorset	**14**	**77.8**	0	0.0	4	22.2	18
Avon, Somerset & Wiltshire	**50**	**64.1**	0	0.0	28	35.9	78
3 Counties	**21**	**65.6**	0	0.0	11	34.4	32
Thames Valley	**66**	**71.0**	0	0.0	27	29.0	93
Central South Coast	**45**	**68.2**	0	0.0	21	31.8	66
Surrey, West Sussex & Hampshire	**19**	**50.0**	0	0.0	**19**	**50.0**	38
Sussex	**18**	**58.1**	2	6.5	11	35.5	31
Kent & Medway	**32**	**62.7**	1	2.0	18	35.3	51
Greater Midlands	**34**	**68.0**	2	4.0	14	28.0	50
North of England	**66**	**67.3**	0	0.0	32	32.7	98
Anglia	**66**	**61.1**	1	0.9	41	38.0	108
Essex	14	43.8	1	3.1	**17**	**53.1**	32
Wales	**2**	**100.0**	0	0.0	0	0.0	2
Unknown	0	**0.0**	0	0.0	2	100.0	2
Total	1,000		31		685		1,716

7.2.3 High volume centres

The greatest number of lymphoma patients were admitted to UCL (Table 36). The majority of admissions (1,632 admissions, 4.1% of all admissions) again took place at the University Hospitals Bristol NHS Foundation Trust (Table 28). Of the 15 highest ranking NHS trusts, in terms of numbers of lymphoma patients, six were TCT centres and 10 were not (Table 36). Of the 15 highest ranking NHS trusts, in terms of admissions for leukaemia patients, five were TCT centres and 10 were not (Table 37). University Hospital of Southampton NHS Trust saw 2.3% of all TYA lymphoma patients (40 patients) but accounted for less than 1.7% of all admissions.

Table 36: Number of lymphoma patients admitted to each NHS trust during the treatment period (top 15 only)

Rank	NHS Trust	Number of patients n	%
1	University College London Hospitals NHS Trust	83	*4.8*
2	The Christie NHS Foundation Trust	79	*4.6*
3	The Royal Marsden NHS Foundation Trust	75	*4.4*
4	Leeds Teaching Hospitals NHS Trust	69	*4.0*
5	University Hospitals Bristol NHS Foundation Trust	64	*3.7*
6	Nottigham University Hospitals NHS Trust	60	*3.5*
7	The Newcastle upon Tyne Hospitals NHS Trust	55	*3.2*
8	Cambridge University Hospitals NHS Foundation Trust	53	*3.1*
9	Oxford Radcliffe Hospitals NHS Trust	52	*3.0*
10	University Hospitals Birmingham NHS Foundation Trust	43	*2.5*
10	University Hospitals Leicester NHS Trust	43	*2.5*
12	Heart of England NHS Foundation Trust	40	*2.3*
12	University Hospital of Southampton NHS Trust	40	*2.3*
14	Sheffield Teaching Hospitals NHS Foundation Trust	39	*2.3*
14	St George's Healthcare NHS Trust	39	*2.3*
15	Barts and the London NHS Trust	37	*2.2*
	Total number of patients	1,716	

TCT centre

Table 37: Number of admissions to each NHS trust during the treatment period, lymphoma patients

Rank	NHS Trust	Number of admissions n	%
1	University Hospitals Bristol NHS Foundation Trust	1,632	*4.1*
2	The Christie NHS Foundation Trust	1,380	*3.5*
3	University College London Hospitals NHS Trust	1,360	*3.4*
4	Leeds Teaching Hospitals NHS Trust	1,327	*3.3*
5	The Royal Marsden NHS Foundation Trust	1,209	*3.0*
6	Sheffield Teaching Hospitals NHS Foundation Trust	1,067	*2.7*
7	Nottigham University Hospitals NHS Trust	1,049	*2.6*
8	Oxford Radcliffe Hospitals NHS Trust	949	*2.4*
9	The Newcastle upon Tyne Hospitals NHS Trust	939	*2.3*
10	Cambridge University Hospitals NHS Foundation Trust	923	*2.3*
11	Barts and the London NHS Trust	850	*2.1*
12	Royal Devon & Exeter NHS Foundation Trust	824	*2.1*
12	University Hospitals Leicester NHS Trust	760	*1.9*
14	Heart of England NHS Foundation Trust	677	*1.7*
15	Royal Cornwall Hospitals NHS Trust	671	*1.7*
	Total number of admissions	39,986	

TCT centre

7.3 Variation in the uptake of specialist care

The characteristics of the lymphoma patients vary slightly between the specialist care groups (Table 38). The age distribution of patients receiving mostly specialist care mirrored that of the patients with limited specialist input. In contrast the patients receiving some specialist input were mostly from the younger age group (aged 15-19 at diagnosis). This group also consisted of more female than male patients, whilst the opposite was seen for the other two groups. In all cases the majority of patients survived to the end of treatment, however in the patients with mostly specialist care this proportion was higher than the other groups (93%). In all cases the most common treatment was chemotherapy alone, with chemoradiotherapy being recorded in between 16.1% and 18.9% of cases.

Table 38: Lymphoma patient details by amount of specialist inpatient care

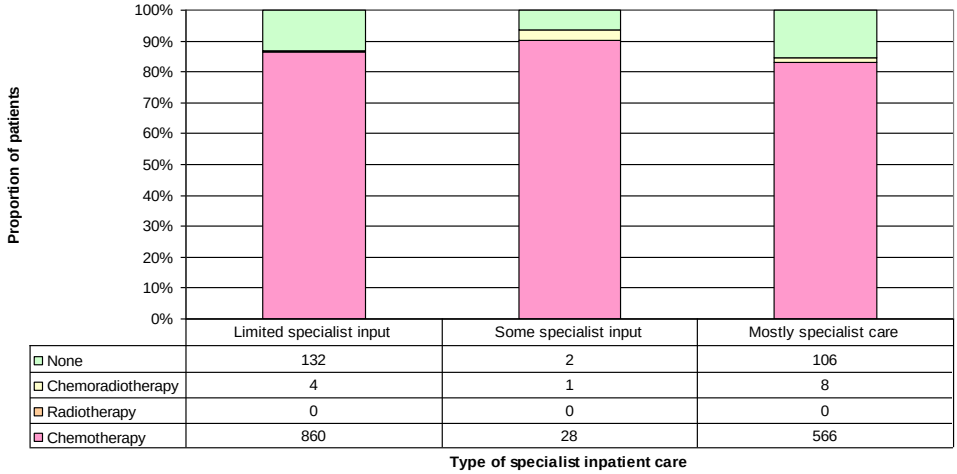
		Type of specialist admissions							
		Limited		**Some TCT**		**Mostly TCT**			
		n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	404	*40.4*	18	*58.1*	290	*42.3*	712	
	20-24	596	*59.6*	13	*41.9*	395	*57.7*	1,004	*0.14*
Gender	**Male**	534	*53.4*	15	*48.4*	390	*56.9*	939	
	Female	466	*46.6*	16	*51.6*	295	*43.1*	777	*0.11*
Diagnostic group	**Non-Hodgkin lymphoma (NHL)**	334	*33.4*	11	*35.5*	187	*27.3*	532	
	Hodgkin lymphoma (HL)	666	*66.6*	20	*64.5*	498	*72.7*	1,184	*0.81*
Deprivation	**Most affluent**	180	*18.0*	4	*12.9*	148	*21.6*	332	
	4	187	*18.7*	4	*12.9*	131	*19.1*	322	
	3	192	*19.2*	8	*25.8*	121	*17.7*	321	
	2	218	*21.8*	3	*9.7*	120	*17.5*	341	
	Most deprived	208	*20.8*	12	*38.7*	163	*23.8*	383	
	Unknown	15	*1.5*	0	*0.0*	2	*0.3*	17	*0.02*
Alive at end of treatment period	**Yes**	866	*86.6*	27	*87.1*	637	*93.0*	1,530	
	No	134	*13.4*	4	*12.9*	48	*7.0*	186	*<0.01*
Treatment received	**Chemotherapy**	727	*72.7*	25	*80.6*	484	*70.7*	1,236	
	Radiotherapy	14	*1.4*	0	*0.0*	22	*3.2*	36	
	Chemoradiotherapy	189	*18.9*	5	*16.1*	116	*16.9*	310	
	None	70	*7.0*	1	*3.2*	63	*9.2*	134	*<0.01*
Total (number of patients)		1,000		31		685		1,716	

7.4 Patient outcomes

7.4.1 Treatment received

Treatment for patients with lymphoma varied across the specialist care groups (Figure 29). The majority of patients in all specialist care groups underwent chemotherapy; very few were reported as having had chemoradiotherapy. In all groups the proportion receiving no treatment was low, it accounted for the smallest proportion in patients with some specialist care (<10%) and accounted for more than 10% in those with limited and mostly specialist care. The median time from diagnosis to first admission was equal across all three groups, the time from diagnosis to first chemotherapy for eligible patients varied slightly, ranging from three to four weeks post diagnosis (Table 39).

Figure 29: Treatment received, by specialist group



	Limited specialist input	Some specialist input	Mostly specialist care
None	132	2	106
Chemoradiotherapy	4	1	8
Radiotherapy	0	0	0
Chemotherapy	860	28	566

Table 39: Time from diagnosis to first admission and first treatment, by specialist group

	Weeks from diagnosis to first admission				Weeks from diagnosis to first chemotherapy			
	Median	Range*			Median	Range*		
Limited specialist input	0	-4	-	61	3	-4	-	105
Some specialist input	0	-4	-	29	3	-2	-	98
Mostly specialist care	0	-4	-	144	4	-4	-	109
* A negative value represents an event before the date of diagnosis								

7.4.2 Survival

Survival to three years was over 75% for all diagnostic and specialist care subgroups of the lymphoma population. Patients diagnosed with non-Hodgkin's lymphoma had poorer survival than those diagnosed with Hodgkin's lymphoma (Figure 30). NHL patients who received some or mostly specialist care had improved survival compared to those with limited specialist care (Figure 31). In contrast HL patients who received mostly specialist input had better survival than those with limited specialist care (Figure 32).

Figure 30: Survival to three years from diagnosis, by diagnostic subtype of lymphoma

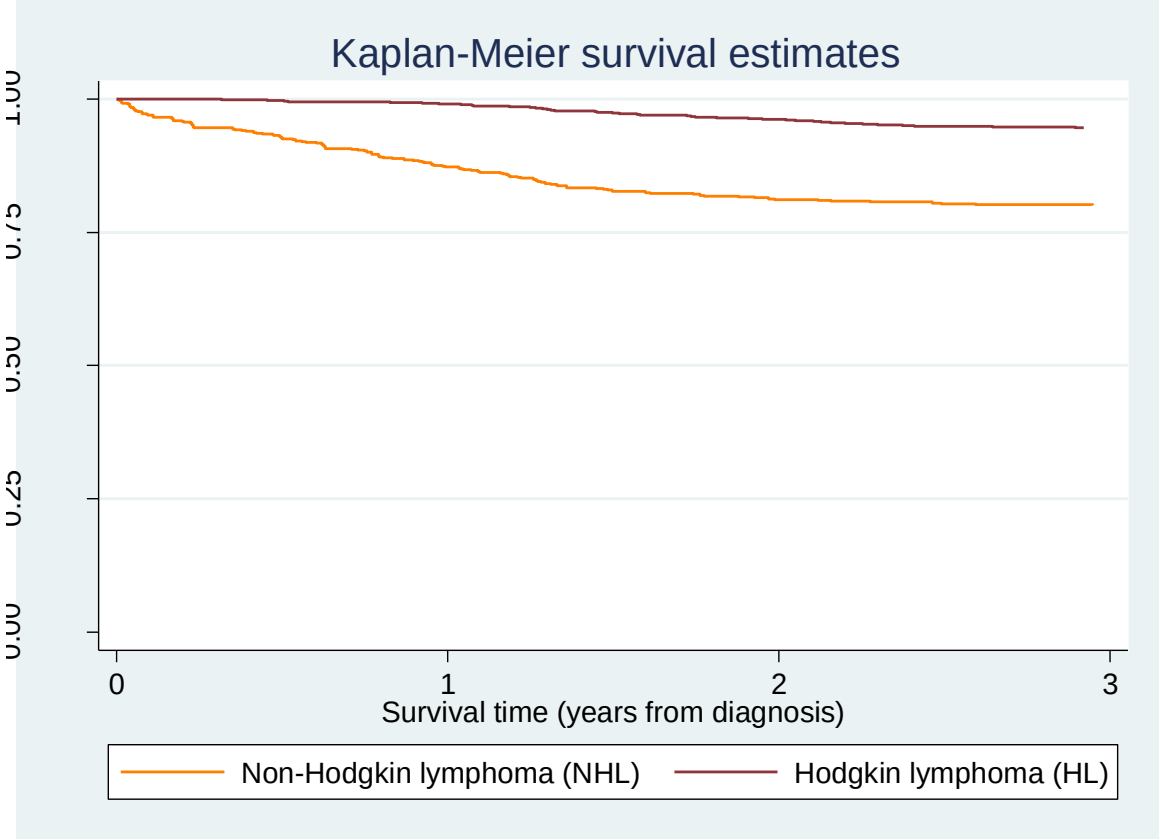


Figure 31: Three year survival by specialist care received for Non-Hodgkin's lymphoma patients

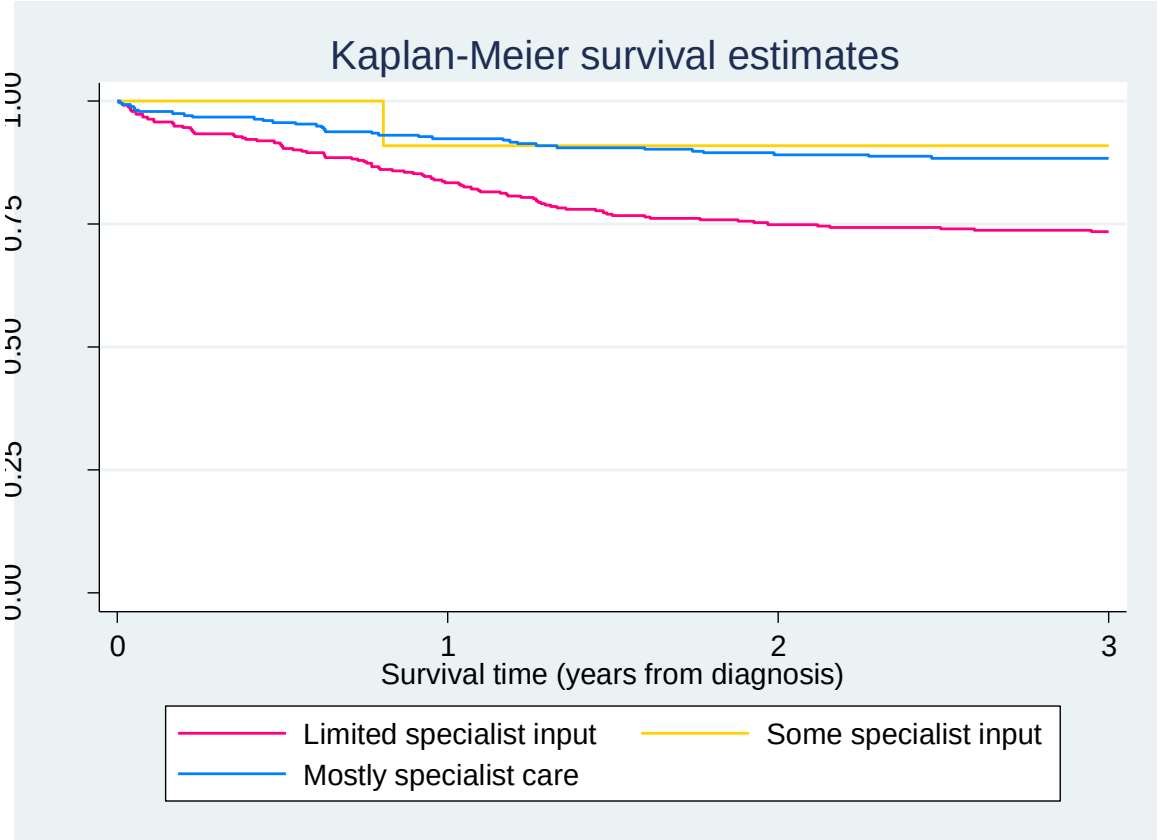
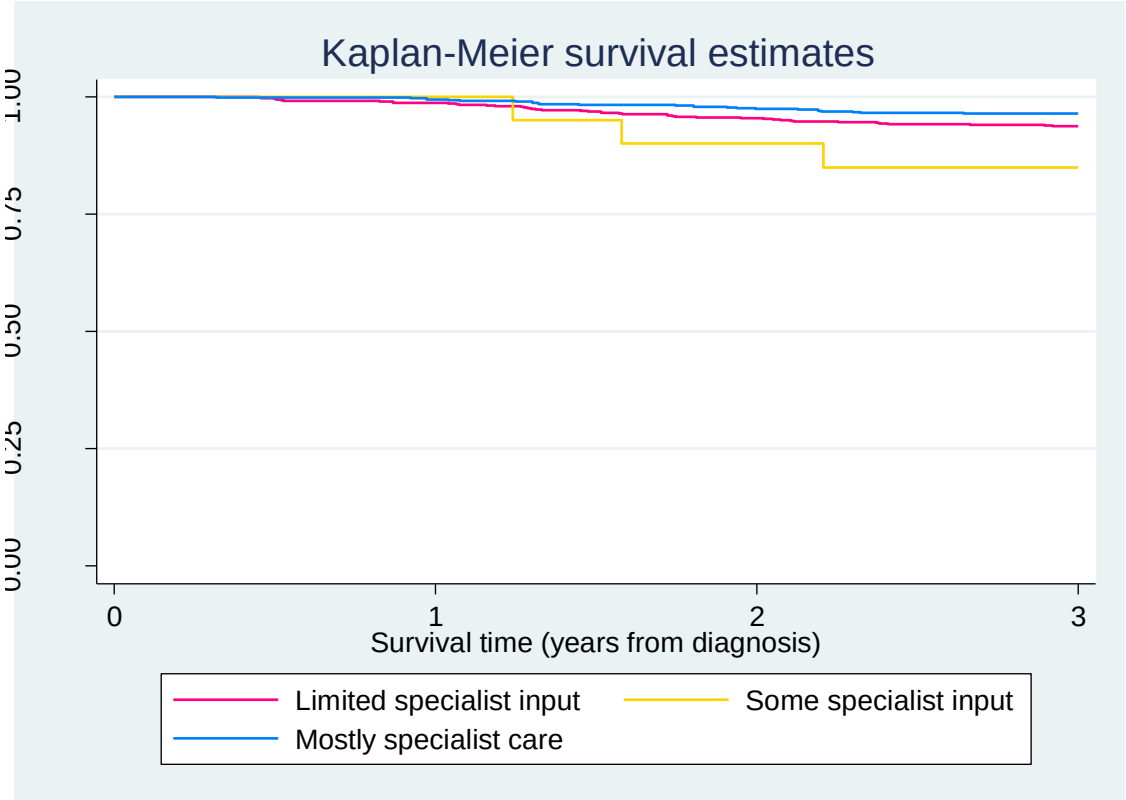


Figure 32: Three year survival by specialist care received for Hodgkin's lymphoma patients



In order to assess which other factors influenced survival for patients diagnosed with a lymphoma, Cox regression modelling was performed. The proportional hazards assumption did not hold when including both Hodgkin's and non-Hodgkin's lymphoma in a single model. When the two diagnostic groups were modelled separately, however, the assumptions held and so two models are presented for lymphoma (Table 41 & Table 42). Each variable was non-statistically significant, as was the global test. There was no evidence found that including age as a categorical, rather than continuous, variable improved fit (p=0.75) and so age was modelled continuously in both cases.

Table 40: Results of the proportional hazards test (stphtest)

		Including diagnostic group			Separate models for diagnostic group		
		rho	**χ2**	**Prob> χ2**	**rho**	**χ2**	**Prob> χ2**
Age at diagnosis		-0.03	0.23	0.63	-0.05	0.18	0.67
Gender	**Male**						
	Female	0.03	0.13	0.72	-0.04	0.09	0.76
Year of diagnosis		0.00	0.00	1.00	0.18	2.04	0.15
Deprivation	**Most deprived**						
	2	0.10	1.90	0.17	0.23	3.56	0.06
	3	0.01	0.02	0.90	-0.06	0.23	0.63
	4	0.07	0.99	0.32	0.16	1.59	0.21
	Most affluent	0.09	1.59	0.21	0.24	3.76	0.05
Amount of specialist care	**Limited**						
	Some	0.09	1.56	0.21	0.06	0.23	0.63
	Mostly	0.03	0.23	0.63	0.06	0.25	0.62
Diagnostic group	**Hodgkin's lymphoma**						
	Non-Hodgkin's lymphoma	0.44	34.68	<0.01			
Global test			**40.19**	**<0.01**		**10.32**	**0.32**

7.4.2.1.1 Non-Hodgkin's lymphoma

For patients diagnosed with non-Hodgkin's lymphoma increasing age had a statistically significant detrimental effect on survival, each single year increase in age was associated with an 8% increased risk of death (HR 1.08 95%CI 1.01-1.15). Those who received mostly specialist care were 62% less likely to die than those who received limited specialist care (HR 0.38 95%CI 0.25-0.57). Gender, year of diagnosis and deprivation had a non-statistically significant effect (Table 41).

Table 41: Cox regression model for non-Hodgkin's

		Haz. Ratio	p value	Lower 95%	Upper 95%
Age at diagnosis		1.08	*0.04*	1.01	1.15
Gender	Male	1.00			
	Female	0.77	*0.18*	0.52	1.13
Year of diagnosis		0.90	*0.06*	0.81	1.00
Deprivation	Most deprived	1.00			
	2	0.71	*0.22*	0.41	1.22
	3	0.55	*0.05*	0.30	0.99
	4	0.76	*0.31*	0.44	1.29
	Most affluent	0.73	*0.24*	0.44	1.23
Amount of specialist care	Limited	1.00			
	Some	0.28	*0.21*	0.04	2.03
	Mostly	0.38	*0.00*	0.25	0.57

7.4.2.1.2 Hodgkin's lymphoma

In contrast to the results seen for non-Hodgkin's lymphoma, age at diagnosis had no effect on survival in Hodgkin's lymphoma. All deprivation groups had improved survival when compared to the most deprived section of the population, although this was only statistically significant for the middle group. The amount of specialist care received was again a key factor influencing outcomes. Patients with mostly specialist care were 44% less likely to die than those with only limited specialist input (HR 0.56 95%CI 0.33-0.95). Patients receiving some specialist input were two fold more likely to die than those with limited input, although this was not statistically significant (Table 42).

Table 42: Cox regression model for Hodgkin's lymphoma

		Haz. Ratio	p value	Lower 95%	Upper 95%
Age at diagnosis		1.00	*0.96*	0.91	1.09
Gender	Male	1.00			
	Female	0.94	*0.81*	0.58	1.53
Year of diagnosis		0.98	*0.80*	0.85	1.13
Deprivation	Most deprived	1.00			
	2	0.83	*0.59*	0.43	1.62
	3	0.39	*0.03*	0.16	0.92
	4	0.79	*0.50*	0.39	1.58
	Most affluent	0.56	*0.14*	0.26	1.21
Amount of specialist care	Limited	1.00			
	Some	2.38	*0.15*	0.73	7.79
	Mostly	0.56	*0.03*	0.33	0.95

7.4.3 Health service usage

The peak in admissions occurred during the same time period for all the specialist care groups (Figure 33). Patients receiving some specialist input had the highest median number of admissions during treatment (Figure 34), the greatest proportion of unplanned admissions (Figure 35) and spent the greatest proportion of the treatment period as an inpatient (Figure 36).

Figure 33: Number of admissions per week, by time from diagnosis and specialist group

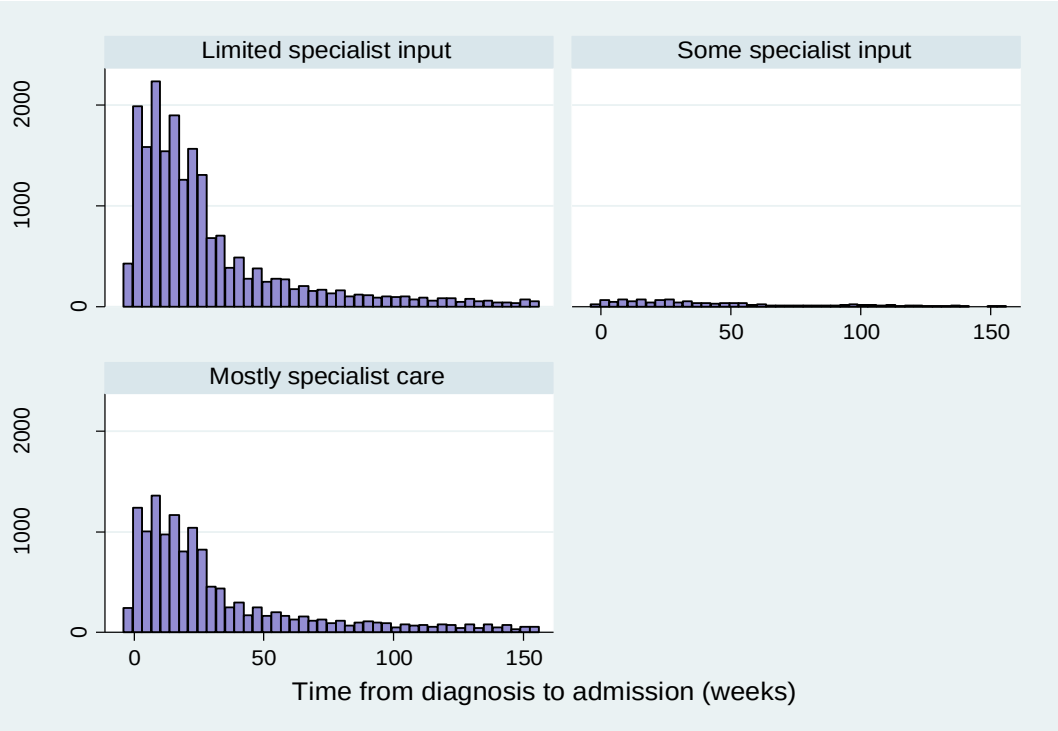


Figure 34: Median number of admissions per patient during treatment, by specialist group

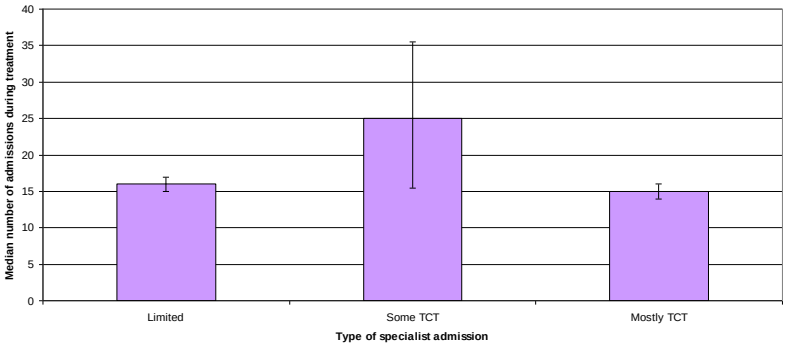


Figure 35: Median proportion of admissions, per patient, during treatment which were unplanned

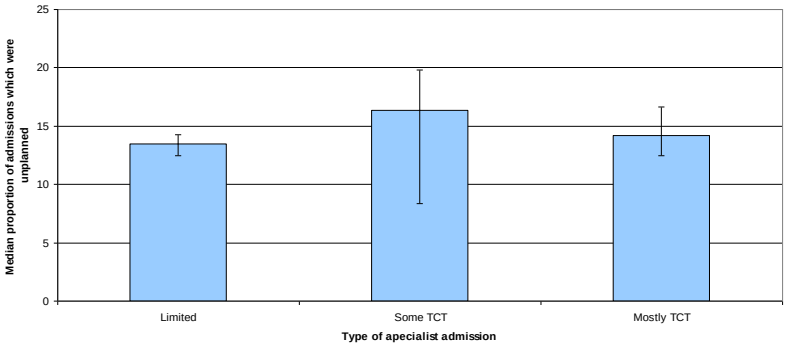
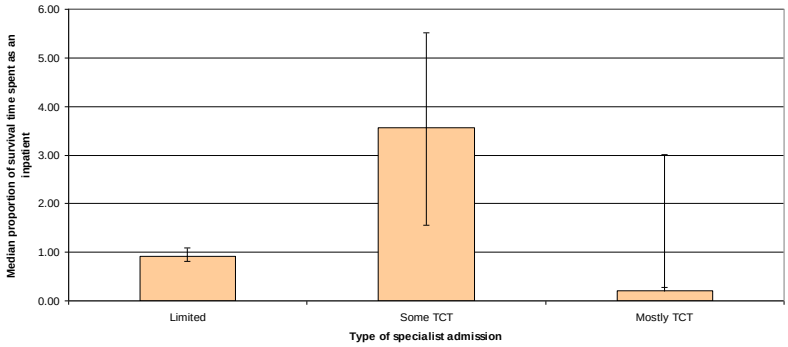


Figure 36: Median proportion of the treatment period spent as an inpatient, per patient



7.4.4 Health service costs

The median total cost of admissions during the treatment period was highest for patients with some specialist input and lowest for those with mostly specialist care (Figure 37). This is reflective of the fact that patients receiving some specialist care also have the highest number of admissions and spend the greatest proportion of the treatment period as inpatients. In an attempt to address this the median cost per admission was calculated for each group (Figure 38), this showed that patients receiving mostly specialist care had the higher cost admissions, whilst patients with limited specialist input remained the lowest.

Figure 37: Median total cost of admissions during treatment, per patient

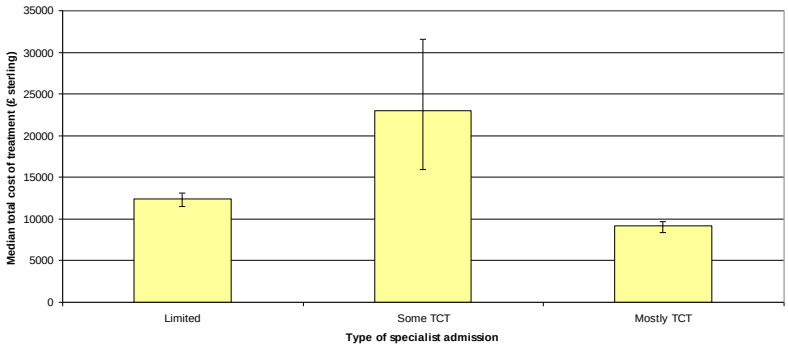
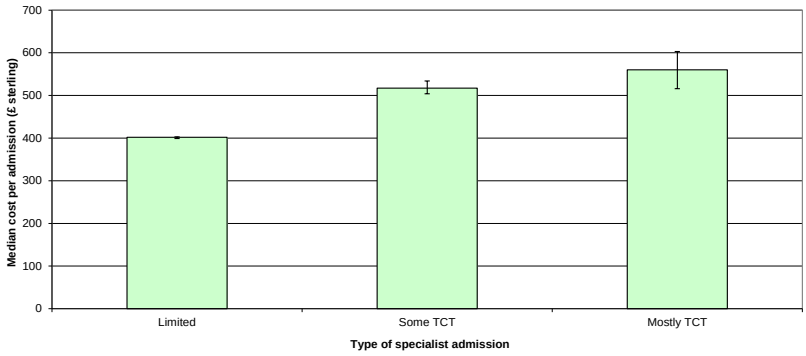


Figure 38: Median cost per admission

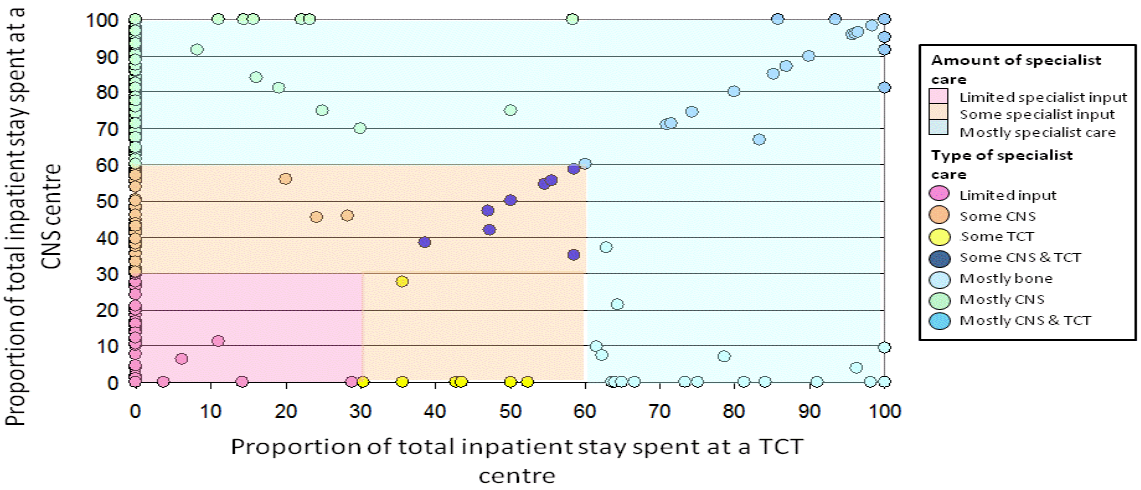


Chapter 8 Central nervous system and other intracranial and intraspinal neoplasms

8.1 Specialist care

Due to the rarity of brain and CNS tumours and the complex nature of their treatment, specialist centres exist for their management. In parallel, patients may also receive treatment at TCT centres and, as such, both types of specialist centre were included in the analysis of this diagnostic group.

Figure 39: Assignment of CNS patients to a "level" of specialist care using the proportion of inpatient time spent in a specialist centre



8.2 Access to specialist care

8.2.1 Hospital catchment areas

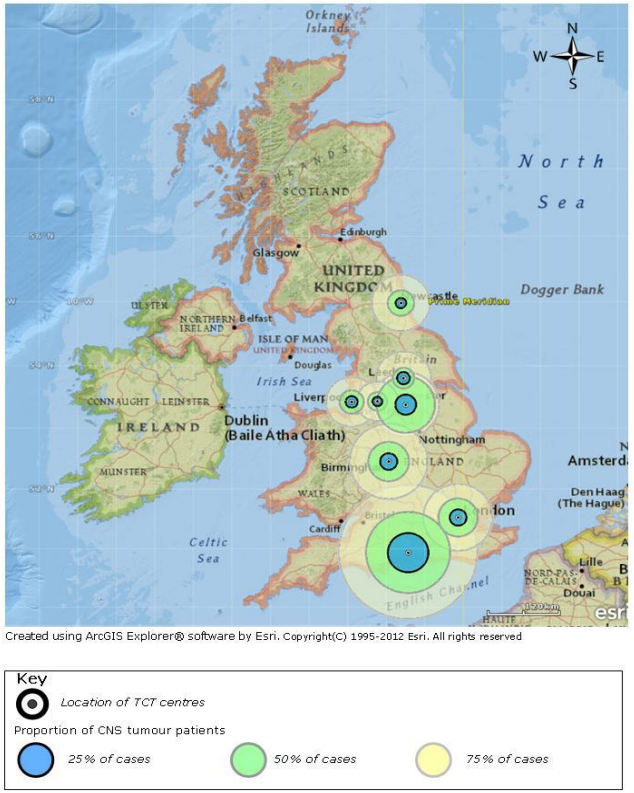
As previously mentioned two types of specialist care centres were in place for the treatment of CNS tumours during the study period and, as a result, both access to TCT centres and CNS specialist centres was assessed.

All TCT centres, except for Sheffield, showed a smaller actual catchment area (Map 10) than theoretical catchment area (Map 11). Other centres were shown to be admitting patients from a smaller area than was suggested when mapping patients according to their proximity to their closest centre.

Again Alder Hey, Southampton, Birmingham and UCL had the greatest proportion of patients, for whom they were the closest centre, who didn't attend any TCT unit during their treatment

period (Table 43). Leeds and Newcastle had some of the lowest levels of patients with no TCT admission during treatment (31.0% and 26.0% respectively). As with both leukaemia and lymphoma very few patients were admitted to a centre other than their closest one. With the exception of the Christie, who admitted 11 patients for whom Alder Hey was the closest unit (Table 43).

Map 11: Site of TCT centres in England (2001-2009) and the residential location of CNS patients closest to each centre



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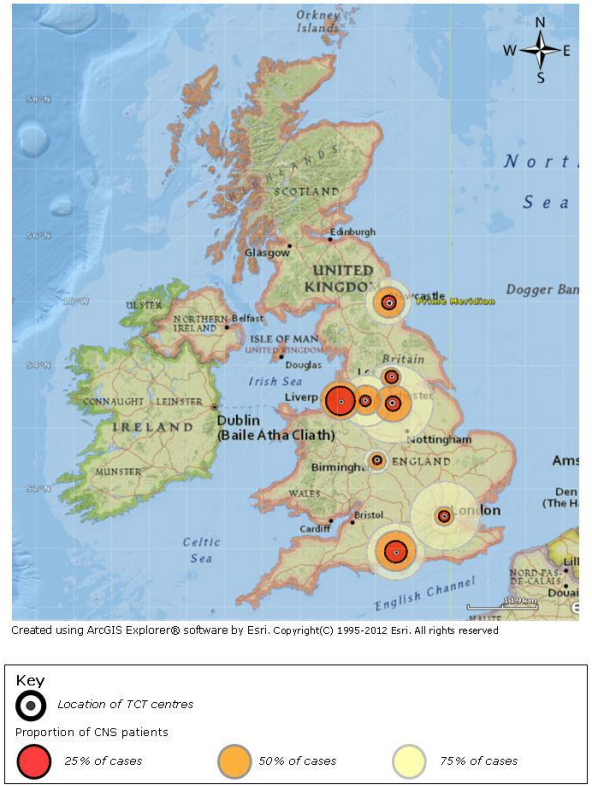
Key
Location of TCT centres
Proportion of CNS tumour patients
25% of cases
50% of cases
75% of cases

Map 10: Site of TCT centres in England (2001-2009) and the residential location of CNS patients admitted to each



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Key
Location of TCT centres
Proportion of CNS patients
25% of cases
50% of cases
75% of cases

Table 43: Numbers of CNS patients closest to each TCT centre, and the centre actually attended

		NHS trust with a TCT unit to which the patient was admitted																		
		Alder Hey Children's NHS Foundation Trust		Leeds Teaching Hospitals NHS Trust		Sheffield Teaching Hospitals NHS Foundation Trust		University Hospital Southampton NHS Foundation Trust		The Christie NHS Foundation Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		University College London Hospitals NHS Foundation Trust		University Hospitals Birmingham NHS Foundation Trust		None		Total
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Closest NHS trust with a TCT unit at the time of admission	Alder Hey Children's NHS Foundation Trust	**4**	*6.7*	**0**	*0*	**1**	*1.7*	**0**	*0*	**11**	*18*	**2**	*3.3*	**0**	*5.6*	**0**	*0*	**42**	*70*	**60**
	Leeds Teaching Hospitals NHS Trust	**0**	*0*	**33**	*61*	**2**	*3.7*	**1**	*1.9*	**1**	*1.9*	**0**	*0*	**0**	*0*	**0**	*0*	**17**	*31*	**54**
	Sheffield Teaching Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**15**	*31*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**34**	*69*	**49**
	University Hospital Southampton NHS Foundation Trust	**0**	*0*	**0**	*0*	**1**	*0.6*	**56**	*31*	**2**	*1.1*	**3**	*1.7*	**2**	*0.9*	**0**	*0*	**114**	*64*	**178**
	The Christie NHS Foundation Trust	**0**	*0*	**1**	*1.2*	**0**	*0*	**0**	*0*	**32**	*37*	**1**	*1.2*	**0**	*1.4*	**1**	*1.2*	**51**	*59*	**86**
	The Newcastle upon Tyne Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**45**	*74*	**0**	*121*	**0**	*0*	**16**	*26*	**61**
	University College London Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*0.4*	**0**	*0*	**0**	*0*	**38**	*0*	**0**	*0*	**189**	*83*	**228**
	University Hospitals Birmingham NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**33**	*28*	**84**	*72*	**117**
	Total	**4**		**34**		**19**		**58**		**46**		**51**		**40**		**34**		**547**		**833**

Increasing distance from the patient's residence to the TCT centre was, again, associated with decreased odds of admission to a TCT centre during the treatment period (Table 44). Every 5km increase in distance between a patient's home address and their closest TCT centre was significantly associated with an 11% decrease in the likelihood of admission (OR 0.89 95%CI 0.85-0.92). A diagnosis of medulloblastoma or other PNET tumours was associated with a two-fold increase in the odds of admission to a TCT centre when compared to astrocytoma (OR 2.58 95%CI 1.34-4.96). A similar effect was seen for female gender and belonging to groups of middle affluence, however neither of these effects were statistically significant.

Table 44: Likelihood of admission to a TCT centre for CNS patients

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	1.32	0.13	0.92	1.90
Age at diagnosis		1.03	0.37	0.97	1.10
Diagnostic group	Astrocytoma	1.00			
	Other gliomas	0.82	0.54	0.45	1.52
	Ependymoma	1.28	0.58	0.54	3.01
	Medulloblastoma & other PNET	2.58	0.00	1.34	4.96
	Other specified intracranial and intraspinal neoplasms	1.08	0.74	0.70	1.66
	Unspecified intracranial and intraspinal neoplasms	1.08	0.86	0.44	2.69
Deprivation	Most deprived	1.00			
	2	0.99	0.96	0.58	1.68
	3	1.21	0.49	0.70	2.10
	4	1.27	0.38	0.74	2.17
	Most affluent	0.66	0.17	0.36	1.20
Distance to nearest TCT centres (increase of 5km)		0.89	<0.01	0.85	0.92

Due to the large number of CNS specialist centres it was not possible to perform mapping of patient distributions in the same way as seen with TCT centres. It was, however, possible to

examine the number of patients attending their closest CNS specialist centre according to road travel distance (Table 45).

The proportion of patients admitted to the centre they resided closest to ranged from 10.0% (Imperial College Healthcare) to 100.0% (UCL). As several of the CNS centres are located in and around London there is likely to be significant patient cross over between trusts and this is demonstrated here (Table 45). Few patients had no admissions to a CNS centre during treatment, with 13 trusts having one or fewer patients with no admissions to a CNS centre. In contrast 38.8% of those living closest to the University Hospitals Coventry and Warwickshire NHS Trust had no admissions to a CNS centre and only 20.9% were admitted there. Very few patients were admitted to a centre other than their closest one, with the exception of UCL which attracted patients from all other trusts, further demonstrating the significant cross flow of patients between NHS trusts.

Table 45: Numbers of CNS patients closest to each CNS centre, and the centre actually attended (part 1)

Closest NHS trust classified as having a CNS specialty at the time of admission	NHS trust to which the patient was admitted: Barking, Havering and Redbridge University Hospitals NHS Trust		Barts and the London NHS Trust		Brighton and Sussex University Hospitals NHS Trust		Cambridge University Hospitals NHS Foundation Trust		Hull and East Yorkshire Hospitals NHS Trust		Imperial College Healthcare NHS Trust		King's College Hospitals NHS Foundation Trust		Lancashir Teaching Hospitals NHS Foundation trust		Leeds Teaching Hospitals NHS Trust		North Bristol NHS Trust		Nottingham University Hospitals NHS Trust		None		Total
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Barking, Havering and Redbridge University Hospitals NHS Trust	8	20.0	4	10.0	0	0.0	3	7.5	0	0.0	0	0.0	17	42.5	0	0.0	0	0.0	0	0.0	0	0.0	2	5.0	40
Barts and the London NHS Trust	0	0.0	6	66.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	11.1	9
Brighton and Sussex University Hospitals NHS Trust	0	0.0	0	0.0	7	53.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	13
Cambridge University Hospitals NHS Foundation Trust	2	4.8	0	0.0	0	0.0	34	81.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4	42
Hull and East Yorkshire Hospitals NHS Trust	0	0.0	0	0.0	1	4.0	0	0.0	19	76.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	4.0	0	0.0	25
Imperial College Healthcare NHS Trust	0	0.0	1	10.0	0	0.0	0	0.0	0	0.0	1	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	10.0	10
King's College Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	12	46.2	0	0.0	0	0.0	0	0.0	0	0.0	2	7.7	26
Lancashir Teaching Hospitals NHS Foundation trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	16	51.6	1	3.2	0	0.0	0	0.0	5	16.1	31
Leeds Teaching Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	3	7.5	0	0.0	0	0.0	0	0.0	33	82.5	0	0.0	0	0.0	1	2.5	40
North Bristol NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.6	0	0.0	0	0.0	0	0.0	60	95.2	1	1.6	1	1.6	63
Nottingham University Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	27	84.4	1	3.1	32
Oxford Radcliffe Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	1	2.1	0	0.0	2	4.3	0	0.0	0	0.0	0	0.0	2	4.3	0	0.0	1	2.1	47
Plymouth Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	11	26.8	0	0.0	4	9.8	41
Royal Free Hampstead NHS Trust	0	0.0	1	2.4	2	4.8	0	0.0	0	0.0	6	14.3	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	2	4.8	42
Salford Royal NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	12	20.7	58
Sheffield Teaching Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	18.8	16
South Tees Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.6	61
Southampton University Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	3.4	0	0.0	0	0.0	0	0.0	0	0.0	1	1.7	58
St George's Healthcare NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	8.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	4.3	46
The Newcastle upon Tyne Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	4
The Walton Centre NHS Foundtion Trust	0	0.0	1	3.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	6.9	29
University College London Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4
University Hospital of North Satffordshire NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.4	3	10.3	29
University Hospitals Coventry and Warwickshire NHS Trust	0	0.0	1	1.5	0	0.0	0	0.0	0	0.0	0	0.0	1	1.5	0	0.0	0	0.0	2	3.0	10	14.9	26	38.8	67
Total	10		14		10		38		22		14		33		16		34		75		40		73		833

Table 46: Numbers of CNS patients closest to each CNS centre, and the centre actually attended (part 2)

NHS trust to which the patient was admitted

Closest NHS trust classified as having a CNS speciality at the time of admission	Oxford Radcliffe Hospitals NHS Trust		Plymouth Hospitals NHS Trust		Royal Free Hampstead NHS Trust		Salford Royal NHS Foundation Trust		Sheffield Teaching Hospitals NHS Foundation Trust		South Tees Hospitals NHS Foundation Trust		Southampton University Hospitals NHS Trust		St George's Healthcare NHS Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		The Walton Centre NHS Foundtion Trust		University College London Hospitals NHS Foundation Trust		University Hospital of North Satffordshire NHS Trust		University Hospitals Coventry and Warwickshire NHS Trust		None		Total
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Barking, Havering and Redbridge University Hospitals NHS Trust	0	0.0	0	0.0	1	2.5	0	0.0	0	0.0	0	0.0	1	2.5	0	0.0	0	0.0	0	0.0	4	10.0	0	0.0	0	0.0	2	5.0	40
Barts and the London NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	22.2	0	0.0	0	0.0	1	11.1	9
Brighton and Sussex University Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	7.7	1	7.7	0	0.0	0	0.0	4	30.8	0	0.0	0	0.0	0	0.0	13
Cambridge University Hospitals NHS Foundation Trust	0	0.0	0	0.0	2	4.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	7.1	0	0.0	0	0.0	1	2.4	42
Hull and East Yorkshire Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	2	8.0	2	8.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	25
Imperial College Healthcare NHS Trust	2	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	10.0	0	0.0	0	0.0	4	40.0	0	0.0	0	0.0	1	10.0	10
King's College Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	8	30.8	0	0.0	0	0.0	4	15.4	0	0.0	0	0.0	2	7.7	26
Lancashir Teaching Hospitals NHS Foundation trust	0	0.0	0	0.0	0	0.0	5	16.1	0	0.0	0	0.0	0	0.0	0	0.0	3	9.7	1	3.2	0	0.0	0	0.0	0	0.0	5	16.1	31
Leeds Teaching Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	1	2.5	1	2.5	1	2.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.5	40
North Bristol NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.6	63
Nottingham University Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	4	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.1	32
Oxford Radcliffe Hospitals NHS Trust	38	80.9	1	2.1	0	0.0	0	0.0	0	0.0	0	0.0	1	2.1	0	0.0	0	0.0	1	2.1	0	0.0	0	0.0	0	0.0	1	2.1	47
Plymouth Hospitals NHS Trust	0	0.0	25	61.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	9.8	41
Royal Free Hampstead NHS Trust	3	7.1	0	0.0	17	40.5	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4	0	0.0	0	0.0	9	21.4	0	0.0	0	0.0	2	4.8	42
Salford Royal NHS Foundation Trust	0	0.0	0	0.0	0	0.0	41	70.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	6.9	0	0.0	1	1.7	0	0.0	12	20.7	58
Sheffield Teaching Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	12	75.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	6.3	0	0.0	0	0.0	3	18.8	16
South Tees Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	15	24.6	0	0.0	0	0.0	45	73.8	0	0.0	0	0.0	0	0.0	0	0.0	1	1.6	61
Southampton University Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	53	91.4	0	0.0	0	0.0	0	0.0	2	3.4	0	0.0	0	0.0	1	1.7	58
St George's Healthcare NHS Trust	2	4.3	0	0.0	1	2.2	0	0.0	0	0.0	0	0.0	0	0.0	34	73.9	0	0.0	0	0.0	3	6.5	0	0.0	0	0.0	2	4.3	46
The Newcastle upon Tyne Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0	2	50.0	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	4
The Walton Centre NHS Foundtion Trust	0	0.0	0	0.0	0	0.0	1	3.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	25	86.2	0	0.0	0	0.0	0	0.0	2	6.9	29
University College London Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	100.0	0	0.0	0	0.0	0	0.0	4
University Hospital of North Satffordshire NHS Trust	0	0.0	0	0.0	0	0.0	3	10.3	0	0.0	0	0.0	0	0.0	0	0.0	1	3.4	2	6.9	0	0.0	19	65.5	0	0.0	3	10.3	29
University Hospitals Coventry and Warwickshire NHS Trust	11	16.4	0	0.0	1	1.5	0	0.0	0	0.0	0	0.0	0	0.0	1	1.5	0	0.0	0	0.0	0	0.0	0	0.0	14	20.9	26	38.8	67
Total	56		26		22		52		19		17		58		46		51		33		40		20		14		73		833

Table 47: Likelihood of admission to a CNS centre

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	1.12	*0.50*	0.81	1.55
Age at diagnosis		1.09	*<0.01*	1.03	1.15
Diagnostic group	Astrocytoma	1.00			
	Other gliomas	0.77	*0.32*	0.45	1.29
	Ependymoma	1.15	*0.74*	0.50	2.65
	Medulloblastoma & other PNET	1.99	*0.09*	0.89	4.42
	Other specified intracranial and intraspinal neoplasms	0.79	*0.23*	0.54	1.16
	Unspecified intracranial and intraspinal neoplasms	0.34	*<0.01*	0.17	0.72
Deprivation	Most deprived	1.00			
	2	1.24	*0.42*	0.74	2.07
	3	0.75	*0.25*	0.46	1.22
	4	1.21	*0.46*	0.73	2.02
	Most affluent	1.69	*0.07*	0.97	2.96
Distance to nearest CNS centre (increase of 5km)		0.94	*<0.01*	0.92	0.99

Increasing age at diagnosis significantly increased the likelihood of admission to a CNS specialist centre by 9% for each year (OR 1.09 95%CI 1.03-1.15) (Table 47). In contrast a diagnosis of unspecified intracranial and intraspinal neoplasm (OR 0.34 95%CI 0.17-0.72) and increasing distance from residence to the closest CNS specialist centre decreased the likelihood of admission to a CNS unit during treatment (OR 0.94 95%CI 0.92-0.99). A diagnosis of unspecified intracranial and intraspinal neoplasm significantly decreased the likelihood of admission to the closest CNS centre by 66.0% when compared with astrocytoma (OR 0.34 95%CI 0.17-0.72). Every 5km increase in distance from the patient's place of residence to their closest CNS centre decreased the likelihood of admission to the centre by 6.0%.

8.2.2 Geographical distribution of patients

Unlike either of the haematological malignancies the majority of patients diagnosed with a CNS tumour spent the greatest proportion of their time as an inpatient in a specialist centre of some form, with the majority of patients receiving mostly specialist care in 27 of the 31 cancer networks (Table 48). The vast majority of this time was spent at a CNS specialist centre, with only the Pan Birmingham network having the majority of patients seen at a TCT centre and Yorkshire, North Trent and West London being the only networks where the majority of patients were treated as inpatients at both TCT and CNS centres (Table 49).

Table 48: Cancer network of residence at diagnosis and level of specialist inpatient care for CNS patients, by the amount of specialist care received (highlighted sections represent the highest proportion of patients for each cancer network)

	Neither		Some		Mostly		Number of patients
	n	%	n	%	n	%	
Lancashire & South Cumbria	7	23.3	4	13.3	19	63.3	30
Greater Manchester & Cheshire	18	26.1	6	8.7	45	65.2	69
Merseyside & Cheshire	4	10.5	6	15.8	28	73.7	38
Yorkshire	2	5.1	1	2.6	36	92.3	39
Humber & Yorskhire Coast	0	0.0	3	14.3	18	85.7	21
North Trent	4	23.5	4	23.5	9	52.9	17
Pan Birmingham	7	25.9	0	0.0	20	74.1	27
Arden	7	33.3	2	9.5	12	57.1	21
Mid Trent	2	10.5	1	5.3	16	84.2	19
Derby/ Burton	1	14.3	0	0.0	6	85.7	7
Leicestershire, Northants & Rutland	3	9.1	6	18.2	24	72.7	33
Mount Vernon	6	66.7	0	0.0	3	33.3	9
West London	2	9.5	0	0.0	19	90.5	21
North London	9	47.4	0	0.0	10	52.6	19
North East London	1	9.1	1	9.1	9	81.8	11
South East London	4	20.0	2	10.0	14	70.0	20
South West London	6	20.7	2	6.9	21	72.4	29
Peninsula	14	36.8	6	15.8	18	47.4	38
Dorset	2	11.1	2	11.1	14	77.8	18
Avon, Somerest & Wiltshire	40	90.9	1	2.3	3	6.8	44
3 Counties	10	76.9	0	0.0	3	23.1	13
Thames Valley	6	12.8	3	6.4	38	80.9	47
Central South Coast	3	7.3	3	7.3	35	85.4	41
Surrey, West Sussex & Hampshire	3	17.6	2	11.8	12	70.6	17
Sussex	1	16.7	0	0.0	5	83.3	6
Kent & Medway	4	17.4	6	26.1	13	56.5	23
Greater Midlands	3	11.5	4	15.4	19	73.1	26
North of England	2	3.0	0	0.0	64	97.0	66
Anglia	6	15.8	1	2.6	31	81.6	38
Essex	2	11.1	3	16.7	13	72.2	18
Wales	2	100.0	0	0.0	0	0.0	2
Unknown	0	0.0	1	16.7	5	83.3	6
Total	181	21.7	70	8.4	582	69.9	833

Table 49: Cancer network of residence at diagnosis and type of specialist inpatient care for CNS patients, by type of specialist care received (highlighted sections represent the highest proportion of patients for each cancer network)

	Neither		TCT		CNS		CNS & TCT		Number of patients
	n	%	n	%	n	%	n	%	
Lancashire & South Cumbria	7	23.3	4	13.3	16	53.3	3	10.0	30
Greater Manchester & Cheshire	18	26.1	14	20.3	35	50.7	2	2.9	69
Merseyside & Cheshire	4	10.5	3	7.9	31	81.6	0	0.0	38
Yorkshire	2	5.1	1	2.6	4	10.3	32	82.1	39
Humber & Yorskhire Coast	0	0.0	0	0.0	21	100.0	0	0.0	21
North Trent	4	23.5	0	0.0	2	11.8	11	64.7	17
Pan Birmingham	7	25.9	20	74.1	0	0.0	0	0.0	27
Arden	7	33.3	1	4.8	12	57.1	1	4.8	21
Mid Trent	2	10.5	0	0.0	15	78.9	2	10.5	19
Derby/ Burton	1	14.3	0	0.0	5	71.4	1	14.3	7
Leicestershire, Northants & Rutland	3	9.1	0	0.0	29	87.9	1	3.0	33
Mount Vernon	6	66.7	0	0.0	2	22.2	1	11.1	9
West London	2	9.5	0	0.0	8	38.1	11	52.4	21
North London	9	47.4	0	0.0	5	26.3	5	26.3	19
North East London	1	9.1	0	0.0	8	72.7	2	18.2	11
South East London	4	20.0	0	0.0	12	60.0	4	20.0	20
South West London	6	20.7	0	0.0	21	72.4	2	6.9	29
Peninsula	14	36.8	0	0.0	24	63.2	0	0.0	38
Dorset	2	11.1	0	0.0	16	88.9	0	0.0	18
Avon, Somerest & Wiltshire	40	90.9	0	0.0	4	9.1	0	0.0	44
3 Counties	10	76.9	1	7.7	2	15.4	0	0.0	13
Thames Valley	6	12.8	0	0.0	41	87.2	0	0.0	47
Central South Coast	3	7.3	0	0.0	35	85.4	3	7.3	41
Surrey, West Sussex & Hampshire	3	17.6	0	0.0	12	70.6	2	11.8	17
Sussex	1	16.7	0	0.0	4	66.7	1	16.7	6
Kent & Medway	4	17.4	0	0.0	18	78.3	1	4.3	23
Greater Midlands	3	11.5	8	30.8	15	57.7	0	0.0	26
North of England	2	3.0	0	0.0	64	97.0	0	0.0	66
Anglia	6	15.8	0	0.0	30	78.9	2	5.3	38
Essex	2	11.1	0	0.0	14	77.8	2	11.1	18
Wales	2	100.0	0	0.0	0	0.0	0	0.0	2
Unknown	0	0.0	0	0.0	6	100.0	0	0.0	6
Total	181	21.7	52	6.2	511	61.3	89	10.7	833

8.2.3 High volume centres

All but one of the NHS trusts ranked in the top 15 in terms of number of CNS patients seen contained a specialist centre of some description (Table 50). Four trusts were recorded as both TCT and CNS specialists, two were recorded as TCT specialists and the remainder were reported to be CNS specialist centres. The Central Manchester University Hospitals NHS Trust accounted for 3.5% of all cases (29 patients). The Christie NHS Foundation Trust ranked 6th in terms of numbers of patients but accounted for the majority of admissions (Table 51). Of the 16 trusts ranked in the top 15 according to number of admissions three were neither TYA nor CNS specialist, The Royal Marsden NHS Trust ranked 4th and accounted for 4.1% of admissions while the University Hospitals Bristol NHS Foundation Trust and Royal Devon & Exeter NHS Foundation Trust ranked 12th and 15th respectively (Table 51).

Table 50: Number of CNS patients admitted to each NHS trust during the treatment period (top 15 only)

Rank	NHS Trust	Number of patients n	%
1	North Bristol NHS Trust	68	*8.2*
2	University Hospital Southampton NHS Foundation Trust	58	*7.0*
3	Oxford Radcliffe Hospitals NHS Trust	52	*6.2*
4	Salford Royal Hospital NHS Trust	51	*6.1*
4	The Newcastle upon Tyne Hospitals NHS Foundation Trust	51	*6.1*
6	St George's Healthcare NHS Trust	44	*5.3*
6	The Christie NHS Foundation Trust	44	*5.3*
8	Nottingham University Hospitals NHS Trust	41	*4.9*
9	University College London Hospitals NHS Foundation Trust	40	*4.8*
10	Cambridge University Hospitals NHS Foundation Trust	38	*4.6*
11	The Walton Centre NHS Foundation Trust	36	*4.3*
12	Leeds Teaching Hospitals NHS Trust	34	*4.1*
12	University Hospitals Birmingham NHS Foundation Trust	34	*4.1*
14	King's College Hospital NHS Foundation Trust	33	*4.0*
15	Central Manchester University Hospitals NHS Trust	29	*3.5*
	Total number of patients	833	

CNS centre
TCT centre
Both

Table 51: Number of admissions to each NHS trust during the treatment period, CNS tumour patients

Rank	NHS Trust	Number of admissions n	%
1	The Christie NHS Foundation Trust	907	*17.9*
2	University Hospital Southampton NHS Foundation Trust	319	*6.3*
3	The Newcastle upon Tyne Hospitals NHS Foundation Trust	220	*4.3*
4	The Royal Marsden NHS Foundation Trust	209	*4.1*
5	University College London Hospitals NHS Foundation Trust	194	*3.8*
6	Lancashire Teaching Hospitals NHS Foundation Trust	185	*3.6*
7	Oxford Radcliffe Hospitals NHS Trust	172	*3.4*
8	Nottingham University Hospitals NHS Trust	169	*3.3*
9	Cambridge University Hospitals NHS Foundation Trust	161	*3.2*
10	Leeds Teaching Hospitals NHS Trust	136	*2.7*
11	North Bristol NHS Trust	120	*2.4*
12	University Hospitals Birmingham NHS Foundation Trust	92	*1.8*
12	University Hospitals Bristol NHS Foundation Trust	92	*1.8*
14	Sheffield Teaching Hospitals NHS Foundation Trust	90	*1.8*
15	Royal Devon & Exeter NHS Foundation Trust	89	*1.8*
	Total number of admissions	5076	

CNS centre
TCT centre
Both

8.3 Variation in the uptake of specialist care

Variation was observed in the characteristics of the brain tumour and CNS patients seen across the specialist care groups (Table 52 &Table 53). Differences were seen when examining the data both by amount and type of specialist care received.

Just over half of all patients receiving limited specialist input were in the younger age group (15 to 19 at diagnosis). In contrast the majority of patients receiving some and mostly specialist care were from the older age group (20 to 24 at diagnosis) following the overall pattern for this tumour group (Table 52). Very little variation was seen by type of specialist care, with the majority of patients from each specialist care group being aged 20 to 24 at diagnosis (Table 53).

Patients were predominantly male; this was seen across all amounts of specialist care (Table 52). The same pattern was seen for all types of specialist care, with the exception of patients receiving CNS and TCT specialist inpatient care, where the majority of patients were female (55.1%) (Table 53).

The most commonly diagnosed tumour was astrocytoma, this was seen in all specialist groups with the exception of those receiving limited specialist input (Table 52) and those with CNS and TCT specialist inpatient care (Table 53), where other specified intracranial and intraspinal neoplasms formed the main part of the group. The proportion of patients with some specialist input diagnosed with other gliomas was lower than seen in any other group, and the proportion with medulloblastoma was higher. This same pattern was seen in patients with both CNS and TCT input (Table 53).

A greater proportion of patients with both CNS and TCT input were alive at the end of the treatment period than any other group (Table 53). A higher proportion of patients receiving some specialist input had been diagnosed with a high grade tumour than those receiving either limited or mostly specialist input (Table 52).

Table 52: CNS patient details by amount of specialist inpatient care

		Limited		Some		Mostly			
		n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	94	*51.9*	*27*	*38.6*	247	*42.4*	368	
	20-24	87	*48.1*	*43*	*61.4*	335	*57.6*	465	*0.40*
Gender	**Male**	95	*52.5*	*44*	*62.9*	305	*52.4*	444	
	Female	86	*47.5*	*26*	*37.1*	277	*47.6*	389	*0.25*
Diagnostic group	**Astrocytoma**	59	*32.6*	*34*	*48.6*	222	*38.1*	315	
	Other gliomas	23	*12.7*	*4*	*5.7*	76	*13.1*	103	
	Ependymoma	11	*6.1*	*6*	*8.6*	23	*4.0*	40	
	Medulloblastoma & other PNET	9	*5.0*	*12*	*17.1*	35	*6.0*	56	
	Other specified intracranial & intraspinal neoplasms	66	*36.5*	*14*	*20.0*	203	*34.9*	283	
	Unspecified intracranial & intraspinal neoplasms	13	*7.2*	*0*	*0.0*	23	*4.0*	36	*<0.01*
Deprivation	**Most affluent**	28	*15.5*	*11*	*15.7*	113	*19.4*	152	
	4	39	*21.5*	*13*	*18.6*	122	*21.0*	174	
	3	46	*25.4*	*12*	*17.1*	100	*17.2*	158	
	2	36	*19.9*	*19*	*27.1*	105	*18.0*	160	
	Most deprived	30	*16.6*	*14*	*20.0*	137	*23.5*	181	
	Unknown	2	*1.1*	*1*	*1.4*	5	*0.9*	8	*0.12*
Alive at end of treatment period	**Yes**	152	*84.0*	*52*	*74.3*	513	*88.1*	717	
	No	29	*16.0*	*18*	*25.7*	69	*11.9*	116	*<0.01*
WHO tumour grade	**I**	53	*29.3*	*15*	*21.4*	146	*25.1*	214	
	II	51	*28.2*	*20*	*28.6*	187	*32.1*	258	
	III	9	*5.0*	*4*	*5.7*	47	*8.1*	60	
	IV	22	*12.2*	*24*	*34.3*	84	*14.4*	130	
	Unknown	46	*25.4*	*7*	*10.0*	118	*20.3*	171	*0.01*
Treatment received	**Surgery**	83	*45.9*	*26*	*37.1*	313	*53.8*	422	
	Surgery & additonal therapy	23	*12.7*	*23*	*32.9*	107	*18.4*	153	
	Chemoradiotherapy	13	*7.2*	*5*	*7.1*	42	*7.2*	60	
	None	62	*34.3*	*16*	*22.9*	120	*20.6*	198	*<0.01*
Total (number of patients)		181		70		582		833	

Table 53: CNS patient details by type of specialist inpatient care

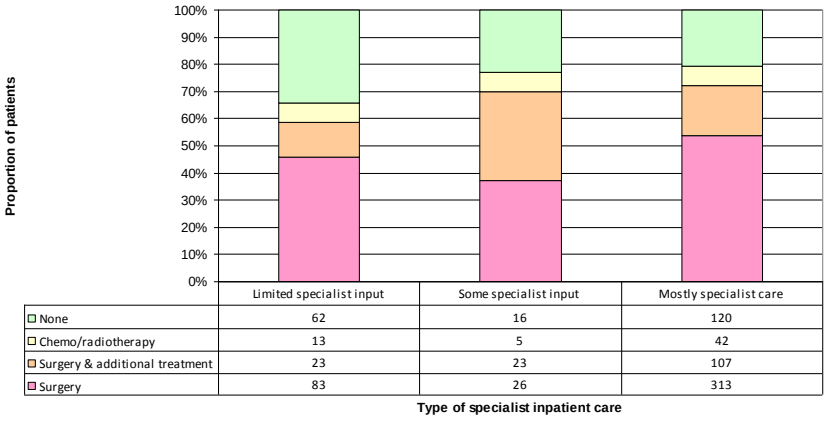
		Limited		CNS		TCT		CNS & TCT			
		n	%	n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	94	*51.9*	*214*	*41.9*	24	*46.2*	*36*	*40.4*	368	
	20-24	87	*48.1*	*297*	*58.1*	28	*53.8*	*53*	*59.6*	465	*0.11*
Gender	**Male**	95	*52.5*	*280*	*54.8*	29	*55.8*	*40*	*44.9*	444	
	Female	86	*47.5*	*231*	*45.2*	23	*44.2*	*49*	*55.1*	389	*0.37*
Diagnostic group	**Astrocytoma**	59	*32.6*	*203*	*39.7*	24	*46.2*	*29*	*32.6*	315	
	Other gliomas	23	*12.7*	*67*	*13.1*	7	*13.5*	*6*	*6.7*	103	
	Ependymoma	11	*6.1*	*22*	*4.3*	2	*3.8*	*5*	*5.6*	40	
	Medulloblastoma & other PNET	9	*5.0*	*33*	*6.5*	4	*7.7*	*10*	*11.2*	56	
	Other specified intracranial & intraspinal neoplasms	66	*36.5*	*169*	*33.1*	10	*19.2*	*38*	*42.7*	283	
	Unspecified intracranial & intraspinal neoplasms	13	*7.2*	*17*	*3.3*	5	*9.6*	*1*	*1.1*	36	*0.03*
Deprivation	**Most affluent**	28	*15.5*	*107*	*20.9*	7	*13.5*	*10*	*11.2*	152	
	4	39	*21.5*	*105*	*20.5*	8	*15.4*	*22*	*24.7*	174	
	3	46	*25.4*	*83*	*16.2*	9	*17.3*	*20*	*22.5*	158	
	2	36	*19.9*	*97*	*19.0*	6	*11.5*	*21*	*23.6*	160	
	Most deprived	30	*16.6*	*113*	*22.1*	22	*42.3*	*16*	*18.0*	181	
	Unknown	2	*1.1*	*6*	*1.2*	0	*0.0*	*0*	*0.0*	8	*<0.01*
Alive at end of treatment period	**Yes**	152	*84.0*	*444*	*86.9*	38	*73.1*	*83*	*93.3*	717	
	No	29	*16.0*	*67*	*13.1*	14	*26.9*	*6*	*6.7*	116	*0.01*
WHO tumour grade	**I**	53	*29.3*	*131*	*25.6*	9	*17.3*	*21*	*23.6*	214	
	II	51	*28.2*	*168*	*32.9*	14	*26.9*	*25*	*28.1*	258	
	III	9	*5.0*	*43*	*8.4*	5	*9.6*	*3*	*3.4*	60	
	IV	22	*12.2*	*77*	*15.1*	12	*23.1*	*19*	*21.3*	130	
	Unknown	46	*25.4*	*92*	*18.0*	12	*23.1*	*21*	*23.6*	171	*0.11*
Treatment received	**Surgery**	83	*45.9*	*278*	*54.4*	17	*32.7*	*44*	*49.4*	422	
	Surgery & additonal therapy	23	*12.7*	*94*	*18.4*	13	*25.0*	*23*	*25.8*	153	
	Chemoradiotherapy	13	*7.2*	*33*	*6.5*	9	*17.3*	*5*	*5.6*	60	
	None	62	*34.3*	*106*	*20.7*	13	*25.0*	*17*	*19.1*	198	*<0.01*
Total (number of patients)		181		511		52		89		833	

8.4 Patient outcomes

8.4.1 Treatment received

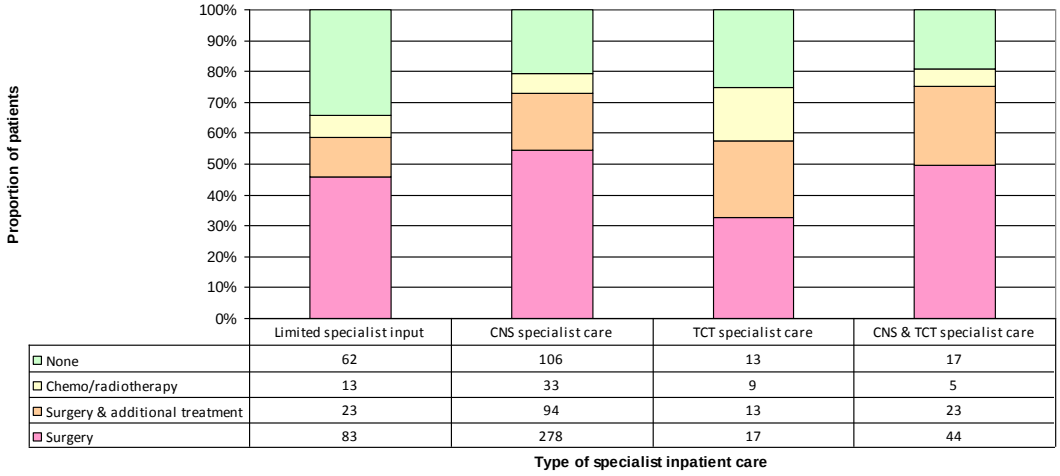
The treatment received by brain and CNS patients was similar across all three groups (Figure 40), with the main difference being seen in those receiving some specialist care that had a greater proportion of patients undergoing surgery with additional therapy than the other two groups. A bigger difference was seen when the patients were grouped according to the type of specialist care they had received (Figure 41). Less than 60% of patients who had TCT specialist care had major surgery, a similar pattern was seen in those with limited specialist input, in contrast over 70% of patients with CNS input, either with or without additional TCT input had a major surgical resection of their tumour. Very few patients underwent chemoradiotherapy without a surgical resection although this was the case for approximately 20% of those with TCT care alone.

Figure 40: Treatment received, by amount of specialist care



	Limited specialist input	Some specialist input	Mostly specialist care
None	62	16	120
Chemo/radiotherapy	13	5	42
Surgery & additional treatment	23	23	107
Surgery	83	26	313

Figure 41: Treatment received, by type of specialist care



	Limited specialist input	CNS specialist care	TCT specialist care	CNS & TCT specialist care
None	62	106	13	17
Chemo/radiotherapy	13	33	9	5
Surgery & additional treatment	23	94	13	23
Surgery	83	278	17	44

The time from diagnosis to first admission was similar across all the specialist care groups, ranging from a week before diagnosis to the week of diagnosis (Table 54 & Table 55). The biggest variation by specialist group was seen for the timing of the first chemotherapy. This was longest for patients with limited specialist input and shortest for those with some specialist care and those with TCT input. However it is important to remember that this is inpatient chemotherapy only and patients may have had outpatient treatment before this.

Table 54: Time from diagnosis to first admission and first treatment, by amount of specialist treatment (a negative value represents an event prior to diagnosis)

	Weeks from diagnosis to first admission		Weeks from diagnosis to first chemotherapy		Weeks from diagnosis to first radiotherapy		Weeks from diagnosis to first surgery	
	Median	Range	Median	Range	Median	Range	Median	Range
Limited specialist input	0	-4 - 77	16.5	0 - 77	-	- - -	0	-1 - 34
Some specialist input	-0.5	-4 - 18	5	0 - 58	7.5	5 - 10	0	-1 - 77
Mostly specialist care	0	-4 - 68	8.5	-1 - 69	3	-1 - 10	0	-3 - 289

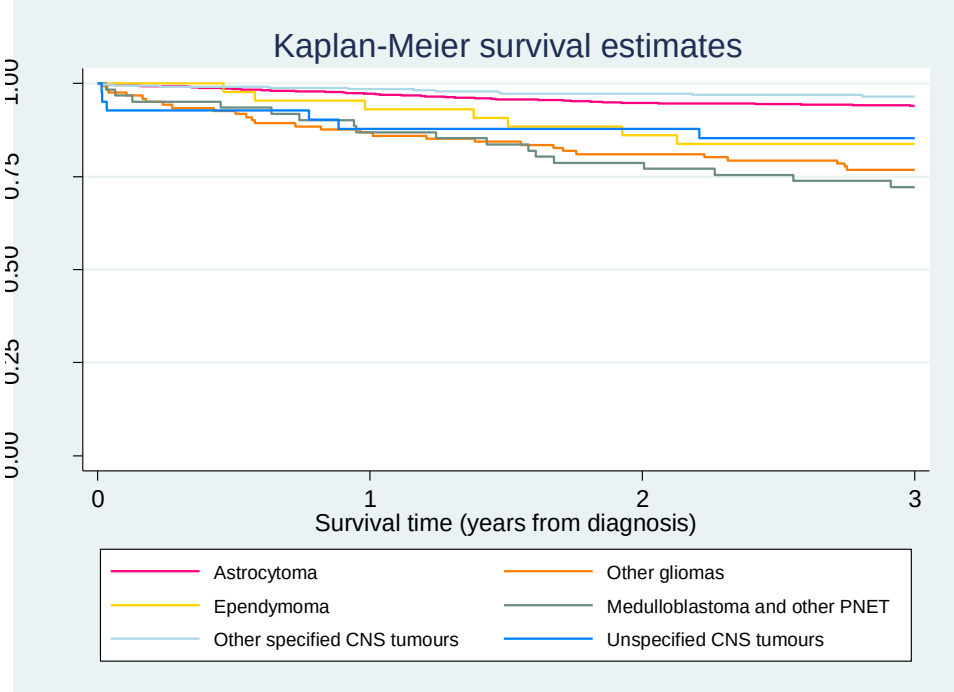
Table 55: Time from diagnosis to first admission and first treatment, by type of specialist treatment (a negative value represents an event prior to diagnosis)

	Weeks from diagnosis to first admission		Weeks from diagnosis to first chemotherapy		Weeks from diagnosis to first radiotherapy		Weeks from diagnosis to first surgery	
	Median	Range	Median	Range	Median	Range	Median	Range
Limited specialist input	0	-4 - 77	16.5	0 - 77	-	- - -	0	-1 - 77
CNS specialist care	0	-4 - 52	8	1 - 69	6	-1 - 10	0	-3 - 289
TCT specialist care	-1	-4 29	6.5	1 33	0	0 - 0	0	0 - 52
CNS & TCT specialist care	0	0 - 68	13	0 - 65	-	- - -	0	0 - 245

8.4.2 Survival

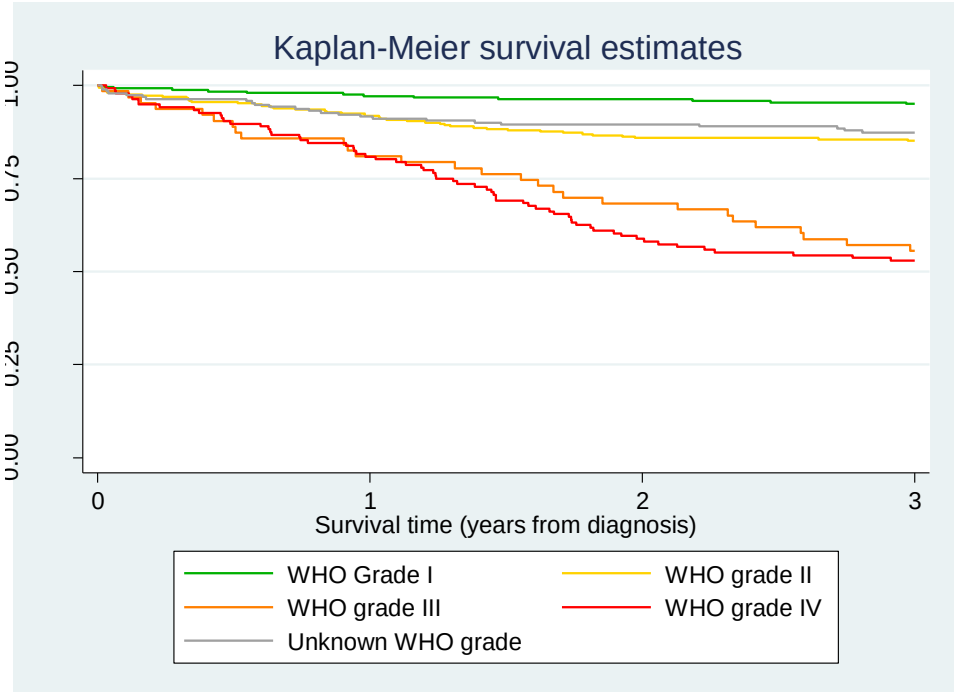
Survival to three years was assessed for multiple factors in brain and CNS tumour patients. There were differences in survival by diagnostic group (Figure 42), with patients with other specified CNS tumours and astrocytoma having the best survival to three years. Medulloblastoma and other PNET tumours and other gliomas had the worst.

Figure 42: Survival to three years from diagnosis, by diagnostic subtype of CNS tumour



Analysis by the grade of tumour showed the pattern which was expected, with higher grade tumours (III and IV) doing worse than those diagnosed with lower grade (I and II) tumours (Figure 43). Those patients with an unknown WHO grade or unclassified tumour had a broadly similar curve to those with a grade II tumour.

Figure 43: Survival to three years from diagnosis, by grade of CNS tumour



Survival also differed when patients were grouped according to the amount of specialist care received. Patients with limited specialist care had the highest proportion surviving to three

years, whilst patients with some specialist input had the lowest (Figure 44). Those with mostly specialist care were seen to fall in the middle of the two other curves.

When patients were grouped according to the type of specialist care they received differences in survival were again seen (Figure 44). Patients receiving limited specialist care and CNS specialist care only had very similar survival, whilst patients for whom the majority of care was at a TCT unit had the lowest survival to three years. Patients with a combination of CNS and TCT specialist care had the best survival, suggesting that there may be different patient and tumour characteristics between the two groups, supported by previous findings (Table 53).

Figure 44: Survival to three years by amount to specialist care received, CNS patients

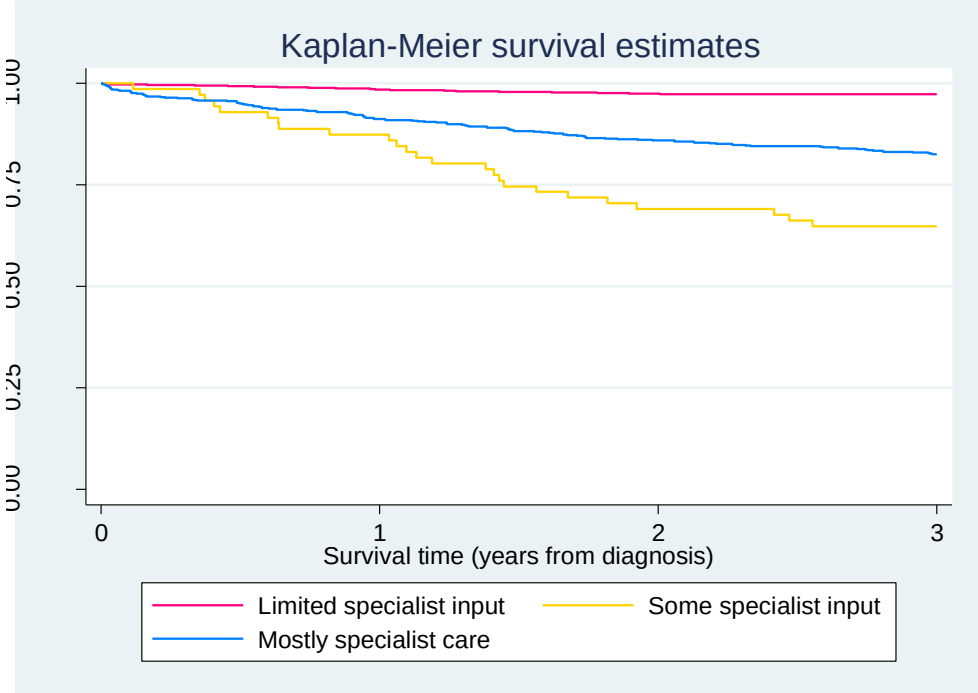
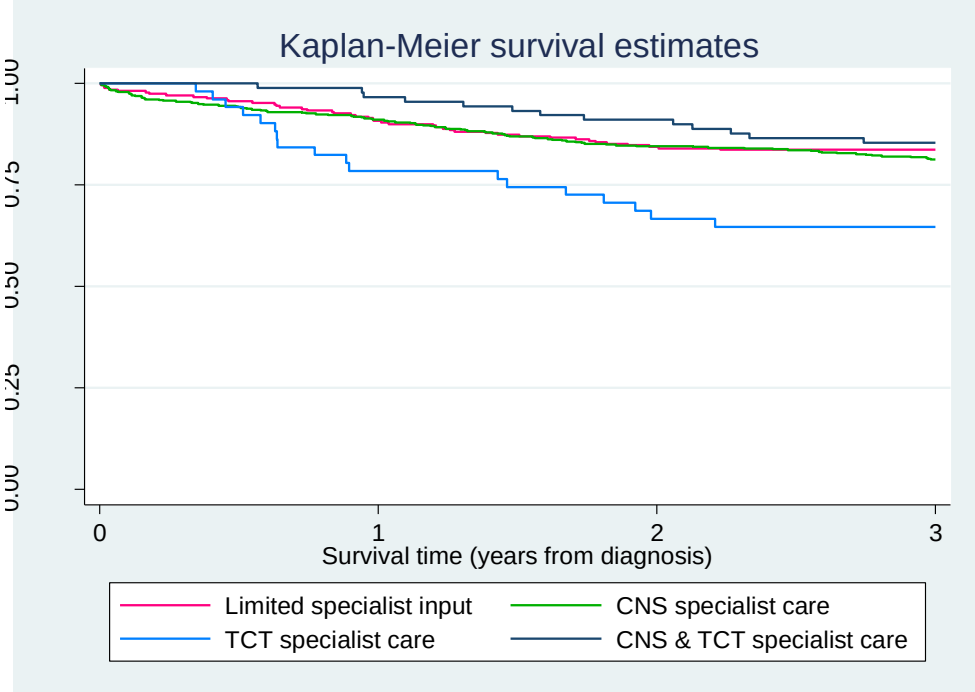


Figure 45: Survival to three years from diagnosis by type of specialist inpatient care, CNS tumours



In order to assess additional factors influencing survival a Cox regression model was produced to include patient characteristics, tumour details and care groupings. As the WHO tumour grades were based upon the tumour morphology and topology (diagnostic sub group), there was likely to be high correlation between these explanatory factors which would make a Cox regression model containing both variables unstable. The pair wise correlation coefficient for WHO tumour grade and diagnostic group was statistically significant showing a strong correlation (p=<0.01). A test of interaction between the WHO grade and the diagnostic group further demonstrated the association between tumour grade and diagnostic group (p=<0.01). The tumour grade was chosen for inclusion in the model rather than diagnostic subgroup as grade explained more of the variation in survival. The improvement in model fit was checked by comparing models after the addition of each variable individually to a baseline model containing neither.

The proportional hazards assumption was tested and the results from this (Table 56) showed that overall this assumption held (p=0.25); this was also the case for each individual covariate (Table 33). When the effect of age at diagnosis was assessed there was no evidence to suggest that including age as a categorical variable produced a better fit (p=0.54) and so age was modelled as a continuous variable.

Table 56: Results of the proportional hazards test (stphtest)

		rho	χ2	Prob> χ2
Age at diagnosis		-0.04	0.24	0.62
Gender	**Male**	1.00		
	Female	0.03	0.20	0.66
Year of diagnosis		0.04	0.28	0.60
Deprivation	**1 (Most deprived)**	1.00		
	2	0.01	0.04	0.85
	3	-0.11	2.46	0.12
	4	0.06	0.62	0.43
	5 (Most affluent)	0.01	0.02	0.88
WHO tumour grade	**Low**	1.00		
	2	-0.07	0.78	0.38
	3	0.10	1.75	0.19
	High	0.07	0.83	0.36
	Unknown	0.02	0.10	0.75
Amount of specialist care	**Limited**	1.00		
	Some	0.17	4.86	0.06
	Mostly	0.15	4.63	0.08
Type of specialist care	**Limited**	1.00		
	CNS	-0.15	4.39	0.06
	TCT	-0.13	3.44	0.06
	CNS & TCT			
Global test			18.19	0.25

Tumour grade and amount of specialist care received were found to have a statistically significant effect on survival (Table 57). Higher grade tumours had significantly worse survival than those with a low grade tumour. Those diagnosed with grade II, III and IV tumours had a 3.3-, 11- and 11.5- fold increased risk of death compared to those with grade I tumours (HR 3.32 95%CI 1.80-6.14, HR 10.99 95%CI 5.64-21.41 and HR 11.54 95%CI 6.32-21.06 respectively). Increasing amounts of specialist care had a non-statistically significant beneficial effect on survival, an effect which became more pronounced as the amount of specialist care increased. Receiving both CNS and TCT specialist care combined was not associated with any difference in risk of death compared to those receiving limited specialist care. Receiving TCT care was associated with a 2.4 fold significantly increased risk of death compared to limited specialist care (HR 2.41 95%CI 1.21-4.83). CNS specialist care was also associated with a slightly increased risk of death, as was increasing deprivation and female gender; however these effects were not statistically significant.

Table 57: Cox regression model for CNS tumours

				Confidence intervals	
		Haz. Ratio	*p value*	Lower 95%	Upper 95%
Age at diagnosis		0.95	*0.06*	0.90	1.00
Gender	**Male**	1.00			
	Female	1.15	*0.36*	0.86	1.54
Year of diagnosis		0.94	*0.17*	0.86	1.03
Deprivation	**Most deprived**	1.00			
	2	1.02	*0.93*	0.64	1.64
	3	1.16	*0.51*	0.74	1.84
	4	1.48	*0.07*	0.96	2.27
	Most affluent	1.23	*0.39*	0.77	1.94
WHO tumour grade	**Low**	1.00			
	2	3.32	*<0.01*	1.80	6.14
	3	10.99	*<0.01*	5.64	21.41
	High	11.54	*<0.01*	6.32	21.06
	Unknown	2.97	*<0.01*	1.53	5.77
Amount of specialist care	**Limited**	1.00			
	Some	0.95	*0.90*	0.49	1.88
	Mostly	0.61	*0.10*	0.34	1.09
Type of specialist care	**Limited**	1.00			
	CNS	1.40	*0.22*	0.82	2.40
	TCT	2.41	*0.01*	1.21	4.83
	CNS & TCT	1.00	*(omitted)*		

8.4.3 Health service usage

The peaks in admissions to hospital were seen at the same time point from diagnosis across all specialist care groups, with the majority of admissions occurring a week before diagnosis to three months post diagnosis (Figure 46 & Figure 47).

Figure 46: Number of admissions per week, by time from diagnosis and amount of specialist care

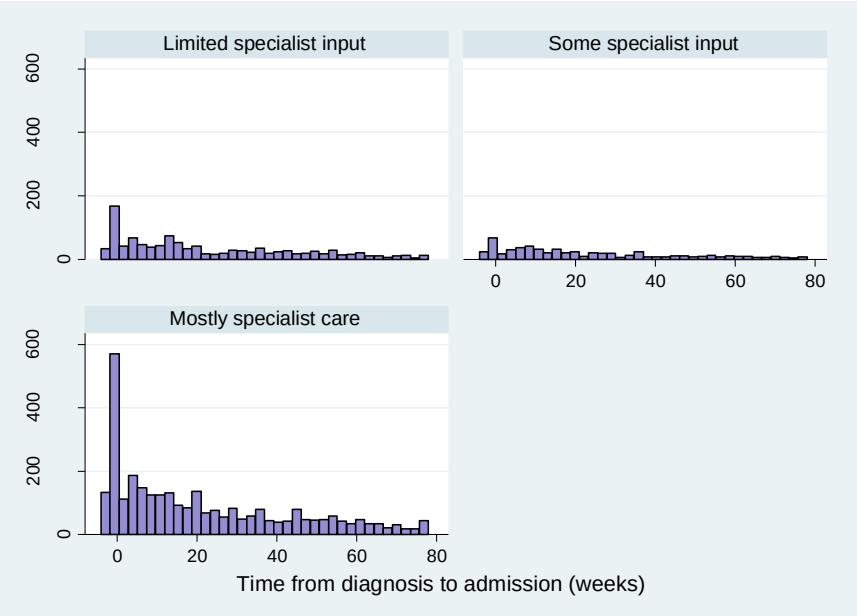
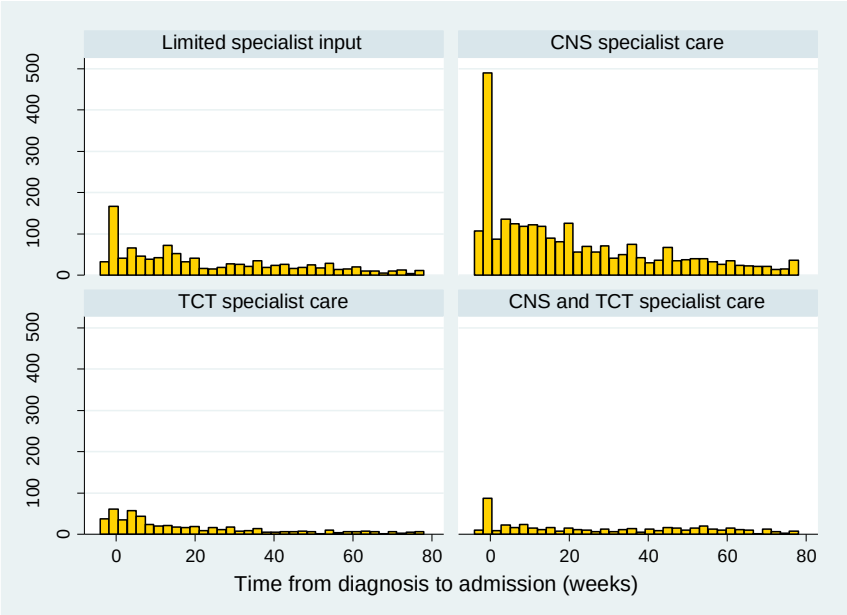


Figure 47: Number of admissions per week, by time from diagnosis and type of specialist care



Patients receiving some specialist care had the highest median number of admissions during treatment (Figure 48), the greatest proportion of unplanned admissions (Figure 49) and spent the largest proportion of their treatment period as an inpatient (Figure 50). Patients who had specialist CNS input had the highest number of admissions during treatment (Figure 48), whilst both those with CNS input and those with limited specialist input had high levels of unplanned admissions (Figure 49). In contrast it was those with TCT specialist care who spent the greatest proportion of their treatment period as an inpatient (Figure 50).

Figure 48: Median number of admissions per patient during treatment

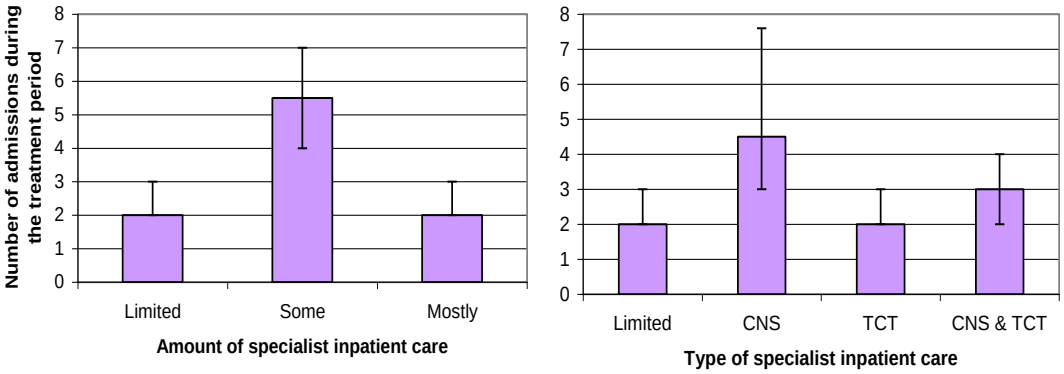


Figure 49: Median proportion of admissions, per patient, during treatment which were unplanned

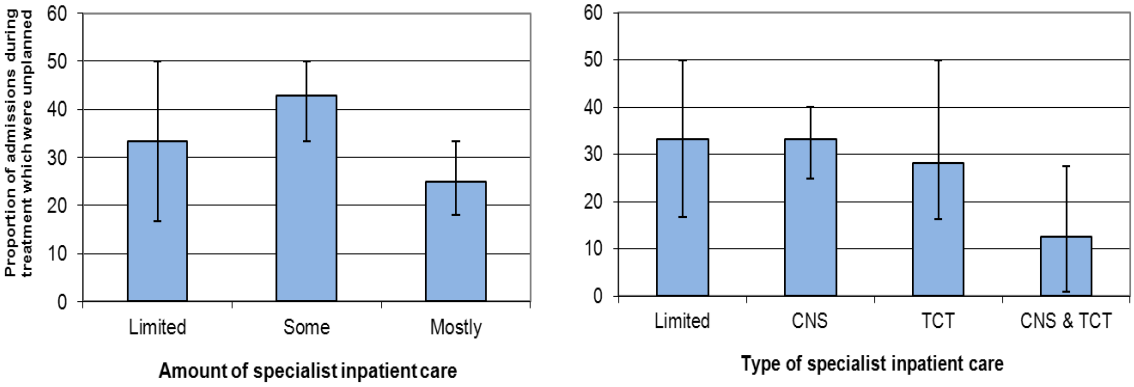
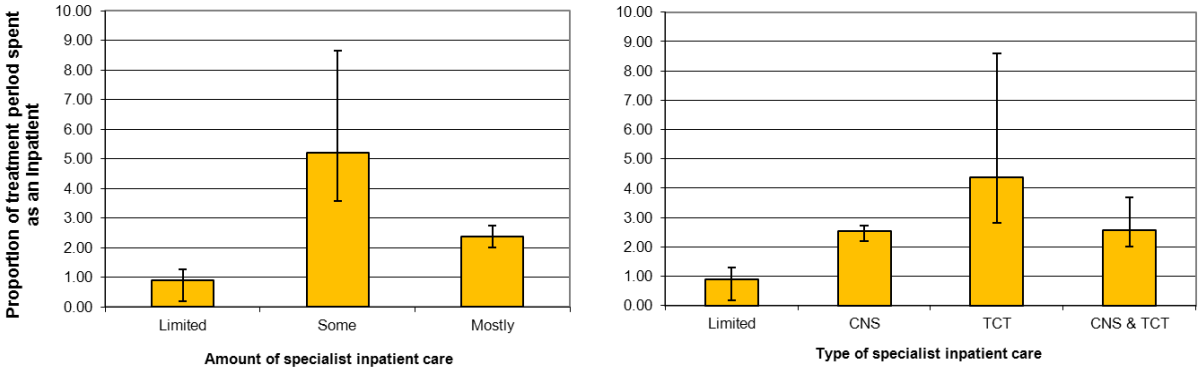


Figure 50 : Median proportion of treatment period spent as an inpatient, per patient



8.4.4 Health service costs

Overall patients with some specialist input and those with TCT specialist input had the highest median total cost of admissions during treatment (Figure 51), this may be due to the fact that they had the highest median number of admissions per patient and spent the greatest proportion of the treatment period as an inpatient when compared to other specialist care

groups. In order to counteract this median cost per admissions was calculated (Figure 52); however this showed the same patterns.

Figure 51: Median total cost of admissions during treatment, per patient

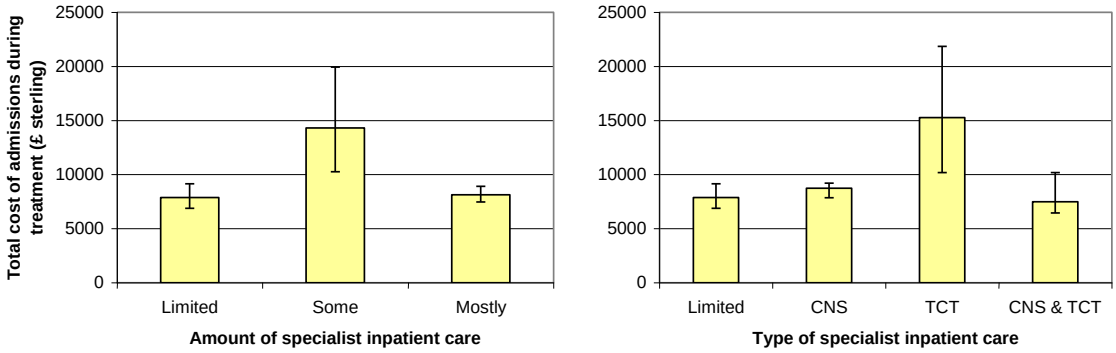
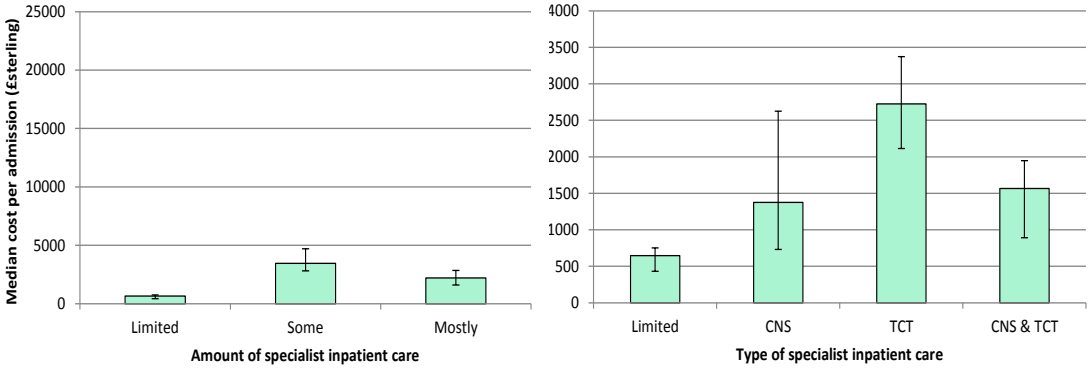


Figure 52: Median cost per admission

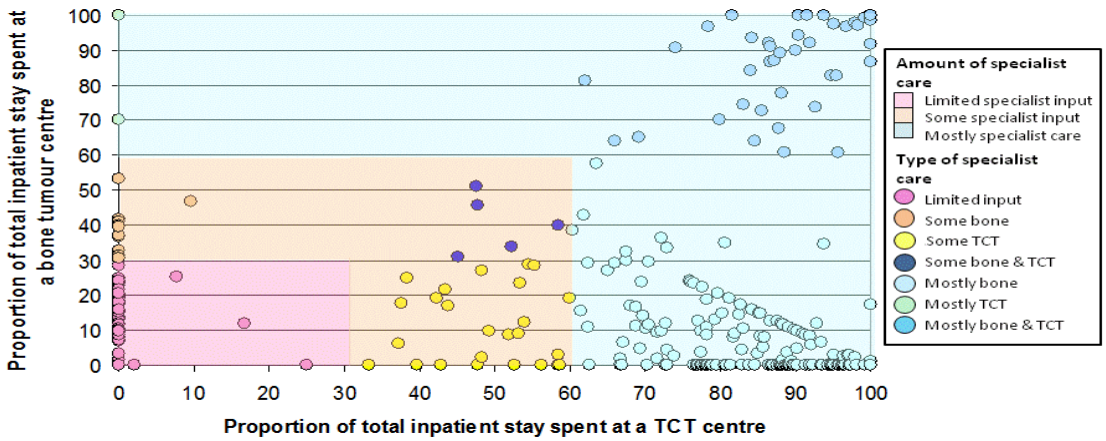


Chapter 9 Osseous and chondromatous neoplasms, Ewing's sarcoma and other neoplasms of bone

9.1 Specialist care

As previously stated treatment for bone tumours was centralised at the time of this study with five centres treating the vast majority of cases and being the only centres permitted to operate. Alongside this patients may have also received parts of their treatment at TCT centres as well as other healthcare facilities. In order to assess the level of specialist care received the proportion of care received in a bone tumour centre was compared to that spent in a TCT centre.

Figure 53: Assignment of bone tumour patients to a "level" of specialist care using the proportion of inpatient time spent in a specialist centre



9.2 Access to specialist care

9.2.1 Hospital catchment areas

Due to the structure of services for TYA bone tumour patients, both bone tumour centres and TCT centres were assessed in the study. TCT centres were assessed first, followed by the access to bone tumour centres.

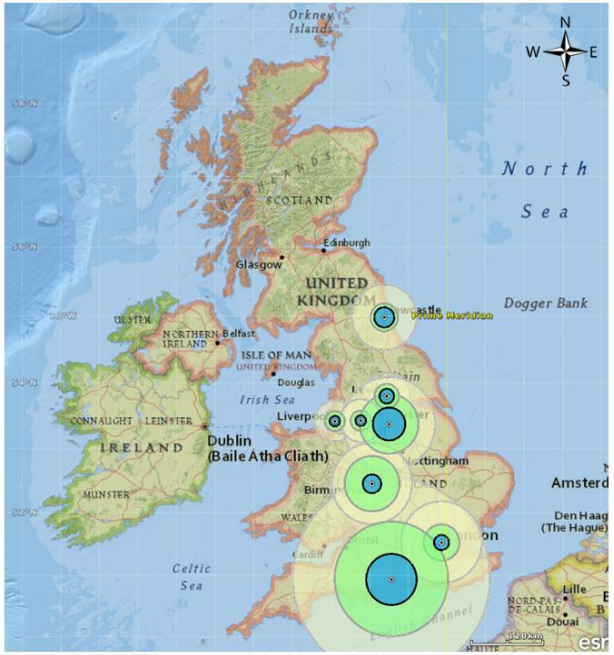
TCT centres at UCL, the Christie, Leeds and Newcastle showed a larger distribution of patients in actuality (Map 12) when compared to their theoretical catchment area (Map 13). Southampton, Birmingham, Sheffield and Alder Hey all attracted patients from closer to the centre than predicted.

Southampton, Birmingham, Sheffield and Alder Hey also had the greatest proportion of patients, for whom they were the closest centre, who were not admitted to a TCT centre during their treatment (Table 58). In contrast 97% who live the closest to Newcastle were

admitted to Newcastle, the remaining patient was admitted to Leeds during the course of their treatment. Leeds and the Christie had similarly low numbers of patients with no TCT admissions during treatment (14% and 17% respectively).

Very few patients were admitted to a centre other than their closest one although the Christie admitted seven patients for whom Alder Hey was the closest unit and UCL who admitted seven patients for whom Southampton was the closest unit (Table 58).

Map 13: Site of TCT centres in England (2001-2009) and the residential location of bone patients closest to each centre



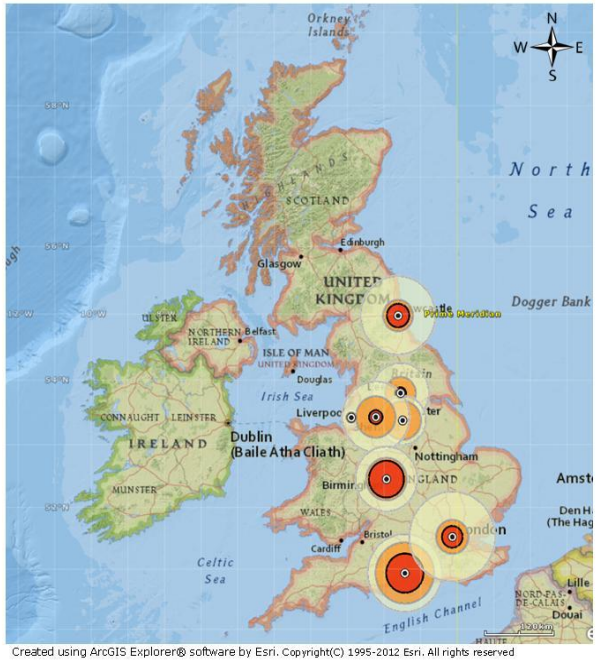
Key

Location of TCT centres

Proportion of bone tumour patients

25% of cases | 50% of cases | 75% of cases

Map 12: Site of TCT centres in England (2001-2009) and the residential location of bone patients admitted to each



Key

Location of TCT centres

Proportion of bone tumour patients

25% of cases | 50% of cases | 75% of cases

Table 58: Numbers of bone tumour patients closest to each TCT centre, and the centre actually attended

		NHS trust with a TCT unit to which the patient was admitted																		
		Alder Hey Children's NHS Foundation Trust		Leeds Teaching Hospitals NHS Trust		Sheffield Teaching Hospitals NHS Foundation Trust		University Hospital Southampton NHS Foundation Trust		The Christie NHS Foundation Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		University College London Hospitals NHS Foundation Trust		University Hospitals Birmingham NHS Foundation Trust		None		Total
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Closest NHS trust with a TCT unit at the time of admission	Alder Hey Children's NHS Foundation Trust	**6**	*19*	**0**	*0*	**0**	*0*	**0**	*0*	**7**	*22*	**0**	*0*	**2**	*0*	**0**	*0*	**17**	*53*	**32**
	Leeds Teaching Hospitals NHS Trust	**0**	*0*	**28**	*80*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*2.9*	**0**	*8.2*	**1**	*2.9*	**5**	*14*	**35**
	Sheffield Teaching Hospitals NHS Foundation Trust	**0**	*0*	**2**	*5.7*	**12**	*34*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*2.9*	**20**	*57*	**35**
	University Hospital Southampton NHS Foundation Trust	**0**	*0*	**1**	*1.5*	**1**	*1.5*	**13**	*20*	**2**	*3*	**0**	*0*	**7**	*0*	**1**	*1.5*	**41**	*62*	**66**
	The Christie NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**21**	*72*	**0**	*0*	**0**	*0*	**3**	*10*	**5**	*17*	**29**
	The Newcastle upon Tyne Hospitals NHS Foundation Trust	**0**	*0*	**1**	*2.7*	**0**	*0*	**0**	*0*	**0**	*0*	**36**	*97*	**0**	*263*	**0**	*0*	**0**	*0*	**37**
	University College London Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**89**	*12*	**0**	*0*	**41**	*32*	**130**
	University Hospitals Birmingham NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**3**	*0*	**35**	*45*	**39**	*51*	**77**
	Total	**6**		**32**		**13**		**13**		**30**		**37**		**101**		**41**		**168**		**441**

Both increasing road travel distance from home to the closest unit and a diagnosis of “other” bone tumour decreased the odds of admission to a TCT unit. Each increment of 5km distance was associated with a 9% decrease in likelihood of admission to the closest TCT centre (OR 0.91 95%CI 0.88-0.94). Those diagnosed with “other” bone tumours were 75% less likely to be admitted to their closest TCT centre than those with osteosarcoma (95% CI 0.13-0.48). Females also had lower odds of being admitted to a TCT unit (OR 0.74 95%CI 0.96-1.14) but the trend was not statistically significant. In contrast, increasing age at diagnosis increased the odds of admission (OR 1.05 95%CI 0.96-1.14), but, again, the effect was not statistically significant (Table 59).

Table 59: Likelihood of admission to a TCT centre for bone tumour patients

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	0.74	0.19	0.46	1.17
Age at diagnosis		1.05	0.29	0.96	1.14
Diagnostic group	Osteosarcoma	1.00			
	Ewing's sarcoma	1.14	0.60	0.70	1.87
	Other	0.25	<0.01	0.13	0.48
Deprivation	Most deprived	1.00			
	2	1.54	0.25	0.74	3.20
	3	0.82	0.57	0.41	1.63
	4	0.65	0.22	0.33	1.29
	Most affluent	1.05	0.89	0.53	2.05
Distance to nearest TCT centres (increase of 5km)		0.91	<0.01	0.88	0.94

The analysis of access to a bone tumour specialist centre demonstrated very different results from that seen when assessing access to TCT centres for the same patient group.

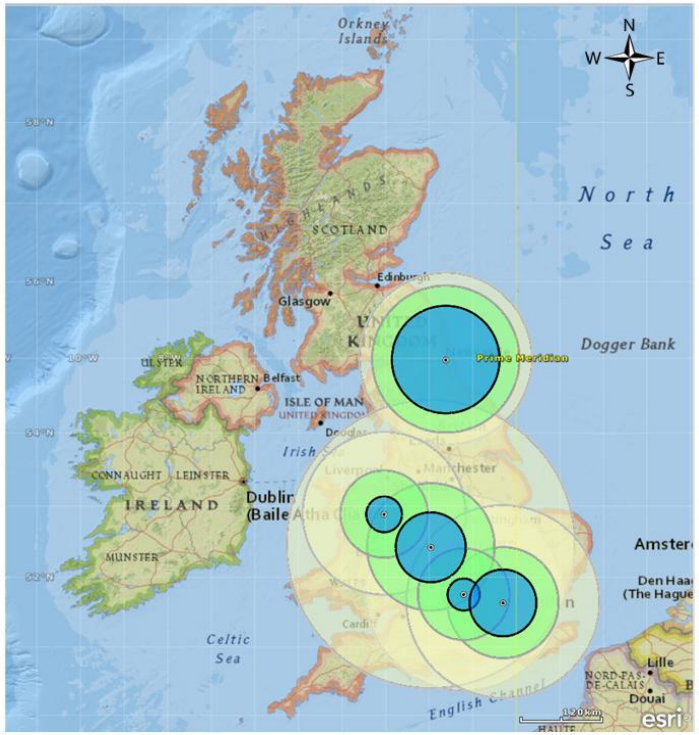
The predicted catchment area of the Royal National Orthopaedic Hospital (Map 15) mirrored almost exactly the actual catchment area of the hospital (Map 14). Of the remaining four bone tumour centres in England at the time of the study, Newcastle and Oxford were shown to attract patients from a smaller geographical area than predicted. The Royal Orthopaedic Hospital, Birmingham and the Robert Jones and Agnes Hunt Orthopaedic Hospital both had a larger catchment area than that which was predicted.

The Robert Jones and Agnes Hunt Orthopaedic Hospital and the Royal National Orthopaedic Hospital had the greatest proportion of patients, for whom they were the closest centre, who were not admitted to a bone tumour centre during their treatment (Table 60). In contrast less than 35.0% of patients who lived the closest to Newcastle, Oxford or the Royal Orthopaedic Hospital had no admissions to a bone tumour centre during treatment.

Unlike the distribution of patients attending a TCT centre (Table 58) there appears to be a large amount of patient mobility when examining admission to a bone tumour centre (Table 60). 28.0% of patients for whom Newcastle was the closest centre, were instead admitted to the Royal Orthopaedic Hospital. 30.0% of those residing closest to the Nuffield Orthopaedic Centre were admitted to the Royal National Orthopaedic Hospital, and 44.0% of those closest to the Robert Jones and Agnes Hunt Orthopaedic Hospital were admitted to the Royal Orthopaedic Hospital.

These results mirror policy and demonstrate the degree to which the centralisation of services for bone tumour patients has been implemented. It strongly suggests that the majority of patients in this group who go on to receive surgery are treated in line with current guidance.

Map 15: Site of bone tumour centres in England and the residential location of bone tumour patients closest to each centre



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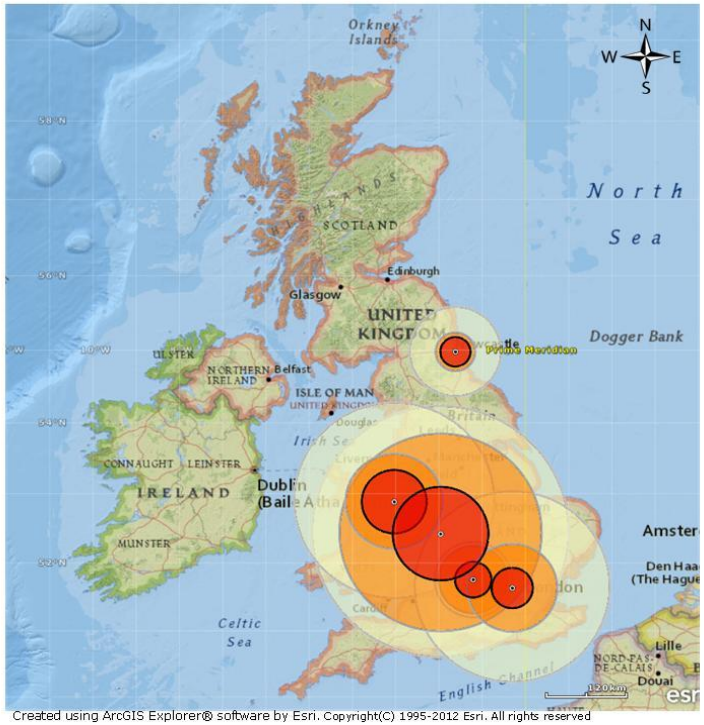
Key

Location of bone tumour centres

Proportion of patients

25% of cases | 50% of cases | 75% of cases

Map 14: Site of bone tumour centres in England and the residential location of patients admitted to each



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Key

Location of bone tumour centres

Proportion of patients

25% of cases | 50% of cases | 75% of cases

Table 60: Numbers of patients closest to each bone tumour centre, and the centre actually attended

		Specialist centre to which the patient was admitted												
		Freeman Hospital, Newcastle		Nuffield Orthopaedic Centre, Oxford		Robert Jones & Agnes Hunt Orthopaedic Hospital, Oswestry		Royal National Orthopaedic Hospital, Stanmore		Royal Orthopaedic Hospital, Birmingham		None		Total
		n	%	n	%	n	%	n	%	n	%	n	%	
Closest bone tumour specialist centre	Freeman Hospital, Newcastle	**37**	*58*	**0**	*0*	**0**	*0*	**1**	*1.6*	**18**	*28*	**8**	*13*	**64**
	Nuffield Orthopaedic Centre, Oxford	**0**	*0*	**11**	*33*	**0**	*0*	**10**	*30*	**2**	*6.1*	**10**	*30*	**33**
	Robert Jones & Agnes Hunt Orthopaedic Hospital, Oswestry	**0**	*0*	**0**	*0*	**3**	*4*	**1**	*1.3*	**33**	*44*	**38**	*51*	**75**
	Royal National Orthopaedic Hospital, Stanmore	**0**	*0*	**4**	*2.9*	**0**	*0*	**67**	*49*	**4**	*2.9*	**62**	*45*	**137**
	Royal Orthopaedic Hospital, Birmingham	**0**	*0*	**0**	*0*	**1**	*0.8*	**7**	*5.6*	**78**	*62*	**40**	*32*	**126**
	Total	**37**		**15**		**5**		**86**		**140**		**158**		**441**

Increasing road travel distance from home to a bone tumour centre decreased the odds of admission to the centre by 3% for every 5km increase (OR 0.97 95%CI 0.94-0.99). This is a much smaller effect than that seen for admission to a TCT centre (Table 59) further supporting the argument that centralisation is being consistently employed.

A diagnosis of Ewing's sarcoma or "other" bone tumour when compared to osteosarcoma also decreased the likelihood of admission to a bone tumour centre (OR 0.29 95%CI 0.18-0.46 and OR 0.40 95%CI 0.21-0.75). Similarly, females had significantly decreased odds of admission to a bone centre, being 49.0% less likely than males to be admitted to a bone tumour centre (OR 0.51 95%CI 0.33-0.79) (Table 61).

Table 61: Likelihood of admission to a bone tumour specialist centre

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	0.51	0.00	0.33	0.79
Age at diagnosis		0.96	0.27	0.88	1.03
Diagnostic group	Osteosarcoma	1.00			
	Ewing's sarcoma	0.29	<0.01	0.18	0.46
	Other	0.40	0.01	0.21	0.75
Deprivation	Most deprived	1.00			
	2	1.12	0.73	0.59	2.14
	3	1.03	0.92	0.55	1.96
	4	1.19	0.61	0.62	2.28
	Most affluent	1.93	0.05	1.01	3.68
Distance to nearest bone centre (increase of 5km)		0.97	<0.01	0.94	0.99

9.2.2 Geographical distribution of patients

In nine of the 31 cancer networks the majority of patients received only limited specialist care (Table 62). Very few patients fell into the some specialist care category and this was not the most common group in any cancer network.

Table 62: Cancer network of residence at diagnosis and level of specialist inpatient care, bone tumours (highlighted sections represent the highest proportion of patients for each cancer network)

	Limited		Some		Mostly		Number of patients
	n	%	n	%	n	%	
Lancashire & South Cumbria	4	33.3	3	25.0	5	41.7	12
Greater Manchester & Cheshire	1	5.6	0	0.0	17	94.4	18
Merseyside & Cheshire	9	45.0	2	10.0	9	45.0	20
Yorkshire	1	3.7	1	3.7	25	92.6	27
Humber & Yorskhire Coast	4	28.6	0	0.0	10	71.4	14
North Trent	1	7.1	3	21.4	10	71.4	14
Pan Birmingham	3	20.0	0	0.0	12	80.0	15
Arden	0	0.0	1	11.1	8	88.9	9
Mid Trent	6	54.5	3	27.3	2	18.2	11
Derby/ Burton	2	25.0	1	12.5	5	62.5	8
Leicestershire, Northants & Rutland	13	81.3	0	0.0	3	18.8	16
Mount Vernon	0	0.0	2	28.6	5	71.4	7
West London	0	0.0	1	5.3	18	94.7	19
North London	1	7.1	1	7.1	12	85.7	14
North East London	1	10.0	1	10.0	8	80.0	10
South East London	0	0.0	4	33.3	8	66.7	12
South West London	4	66.7	0	0.0	2	33.3	6
Peninsula	19	95.0	1	5.0	0	0.0	20
Dorset	4	80.0	0	0.0	1	20.0	5
Avon, Somerest & Wiltshire	8	80.0	0	0.0	2	20.0	10
3 Counties	1	14.3	1	14.3	5	71.4	7
Thames Valley	5	29.4	5	29.4	7	41.2	17
Central South Coast	9	69.2	2	15.4	2	15.4	13
Surrey, West Sussex & Hampshire	0	0.0	1	25.0	3	75.0	4
Sussex	3	25.0	4	33.3	5	41.7	12
Kent & Medway	1	11.1	1	11.1	7	77.8	9
Greater Midlands	3	13.6	1	4.5	18	81.8	22
North of England	0	0.0	0	0.0	36	100.0	36
Anglia	15	78.9	2	10.5	2	10.5	19
Essex	0	0.0	2	15.4	11	84.6	13
Wales	0	0.0	0	0.0	14	100.0	14
Unknown	2	25.0	0	0.0	6	75.0	8
Total	120	27.2	43	9.8	278	63.0	441

The majority of patients receiving mostly specialist inpatient care received TCT input. Patients in only two networks (Thames Valley and Wales) received bone specialist care as their majority specialist input. Five networks treated the majority of patients in bone and TCT specialist centres combined (Table 63).

Table 63: Cancer network of residence at diagnosis and type of specialist inpatient care, bone tumours (highlighted sections represent the highest proportion of patients for each cancer network)

	Limited		Bone		TCT		Bone & TCT		Number of patients
	n	%	n	%	n	%	n	%	
Lancashire & South Cumbria	4	33.3	0	0.0	7	58.3	1	8.3	12
Greater Manchester & Cheshire	1	5.6	1	5.6	16	88.9	0	0.0	18
Merseyside & Cheshire	9	45.0	2	10.0	9	45.0	0	0.0	20
Yorkshire	1	3.7	0	0.0	26	96.3	0	0.0	27
Humber & Yorskhire Coast	4	28.6	0	0.0	10	71.4	0	0.0	14
North Trent	1	7.1	3	21.4	10	71.4	0	0.0	14
Pan Birmingham	3	20.0	2	13.3	1	6.7	9	60.0	15
Arden	0	0.0	2	22.2	4	44.4	3	33.3	9
Mid Trent	6	54.5	5	45.5	0	0.0	0	0.0	11
Derby/ Burton	2	25.0	2	25.0	1	12.5	3	37.5	8
Leicestershire, Northants & Rutland	13	81.3	0	0.0	3	18.8	0	0.0	16
Mount Vernon	0	0.0	0	0.0	6	85.7	1	14.3	7
West London	0	0.0	7	36.8	12	63.2	0	0.0	19
North London	1	7.1	2	14.3	11	78.6	0	0.0	14
North East London	1	10.0	0	0.0	9	90.0	0	0.0	10
South East London	0	0.0	0	0.0	11	91.7	1	8.3	12
South West London	4	66.7	0	0.0	2	33.3	0	0.0	6
Peninsula	19	95.0	1	5.0	0	0.0	0	0.0	20
Dorset	4	80.0	0	0.0	1	20.0	0	0.0	5
Avon, Somerest & Wiltshire	8	80.0	0	0.0	1	10.0	1	10.0	10
3 Counties	1	14.3	1	14.3	1	14.3	4	57.1	7
Thames Valley	5	29.4	7	41.2	5	29.4	0	0.0	17
Central South Coast	9	69.2	3	23.1	0	0.0	1	7.7	13
Surrey, West Sussex & Hampshire	0	0.0	0	0.0	4	100.0	0	0.0	4
Sussex	3	25.0	1	8.3	8	66.7	0	0.0	12
Kent & Medway	1	11.1	0	0.0	8	88.9	0	0.0	9
Greater Midlands	3	13.6	2	9.1	5	22.7	12	54.5	22
North of England	0	0.0	0	0.0	1	2.8	35	97.2	36
Anglia	15	78.9	0	0.0	4	21.1	0	0.0	19
Essex	0	0.0	0	0.0	13	100.0	0	0.0	13
Wales	0	0.0	13	92.9	1	7.1	0	0.0	14
Unknown	2	25.0	4	50.0	0	0.0	2	25	8
Total	120	27.2	58	13.2	190	43.1	73	16.6	441

9.2.3 High volume centres

Three of the trusts ranked in the top 15 in terms of numbers of bone tumour patients were bone tumour specialist centres, one was both a bone and a TYA specialist centre (Newcastle), six were TYA specialist centres and the remainder were neither (Table 64). The Royal Orthopaedic Hospital and the Royal National Orthopaedic Hospital ranked 1st and 3rd in terms of patient numbers, but 4th and 15th in terms of admissions (Table 65). This would be expected as often surgery is undertaken at the bone tumour specialist centres but chemotherapy/ radiotherapy are performed elsewhere.

Table 64: Number of bone tumour patients admitted to each NHS trust during the treatment period (top 15 only)

Rank	NHS Trust	Number of patients n	%
1	The Royal Orthopaedic Hospital NHS Foundation Trust	138	*31.3*
2	University College London Hospitals	103	*23.4*
3	Royal National Orthopaedic Hospital NHS Trust	86	*19.5*
4	University Hospitals Birmingham NHS Foundation Trust	41	*9.3*
4	The Newcastle upon Tyne Hospitals NHS Foundation Trust	37	*8.4*
6	Leeds Teaching Hospitals NHS Trust	32	*7.3*
7	The Christie NHS Foundation Trust	30	*6.8*
8	Cambridge University Hospitals NHS Foundation Trust	19	*4.3*
9	University Hospitals Bristol NHS Foundation Trust	17	*3.9*
10	Clatterbridge Centre for Oncology NHS Trust	14	*3.2*
10	Oxford Radcliffe Hospitals NHS Trust	14	*3.2*
12	Nuffield Orthopaedic Centre NHS Trust	13	*2.9*
12	Sheffield Teaching Hospitals NHS Foundation Trust	13	*2.9*
12	University Hospital Southampton NHS Trust	13	*2.9*
15	University Hospitals of Leicester NHS Trust	12	*2.7*
15	Nottingham University Hospitals NHS Trust	12	*2.7*
	Total number of patients	441	

Bone centre
TCT centre
Both

Table 65: Number of admissions to each NHS trust during the treatment period, bone tumour patients

Rank	NHS Trust	Number of admissions n	%
1	University College London Hospitals	1,435	*15.2*
2	The Christie NHS Foundation Trust	1,074	*11.3*
3	The Newcastle upon Tyne Hospitals NHS Foundation Trust	821	*8.7*
4	The Royal Orthopaedic Hospital NHS Foundation Trust	741	*7.8*
5	Leeds Teaching Hospitals NHS Trust	734	*7.8*
6	University Hospitals Birmingham NHS Foundation Trust	568	*6.0*
7	Sheffield Teaching Hospitals NHS Foundation Trust	268	*2.8*
8	University Hospital Southampton NHS Trust	250	*2.6*
9	Cambridge University Hospitals NHS Foundation Trust	249	*2.6*
10	University Hospitals Bristol NHS Foundation Trust	248	*2.6*
11	University Hospitals of Leicester NHS Trust	243	*2.6*
12	Royal Devon & Exeter NHS Foundation Trust	188	*2.0*
13	Nottingham University Hospitals NHS Trust	186	*2.0*
14	Clatterbridge Centre for Oncology NHS Trust	182	*1.9*
15	Royal National Orthopaedic Hospital NHS Trust	180	*1.9*
	Total number of admissions	9,463	

Bone centre
TCT centre
Both

9.3 Variation in the uptake of specialist care

Age at diagnosis showed variation by both amount of specialist care received (Table 66) and by the type of specialist care (Table 67). In all groups, except for patients with both specialist bone and TCT input, patients were predominantly from the younger age group (15 to 19 at diagnosis). The reverse was seen in patients with specialist bone and TCT input, where the majority of patients (52.1%) were from the older group (20 to 24 at diagnosis) (Table 67).

In keeping with the patterns of incidence of this tumour group, across all specialist care groups the majority of patients were male, with only 38.3% of patients being female.

Variation was seen in the distribution of diagnostic sub-groups by specialist care group. Patients with limited specialist input had an equal division of osteosarcoma and Ewing's sarcoma diagnoses, with only a small number of patients diagnosed with 'other' bone

tumours. A similar pattern was seen in patients receiving some specialist input (Table 66). However, half of all patients with mostly specialist care had been diagnosed with an osteosarcoma, which was higher than that seen in other groups. Patients with bone tumour specialist input (with or without TCT input) had more diagnoses of osteosarcoma than any other specialist care group (51.7% and 54.8% respectively). Patients with bone tumour input had lower incidence of Ewing's sarcoma and higher incidence of 'other' bone tumours than other specialist care groups (Table 67).

The lowest proportion of patients surviving to the end of the treatment period was seen in those receiving some specialist input (46.5%) (Table 66) and in patients with TCT specialist input (47.0%) (Table 67). The highest proportion of patients surviving to the end of treatment had bone tumour specialist input (87.9%) (Table 67).

The majority of patients in all specialist care groups had undergone surgery, either with or without chemoradiotherapy. Very few patients had no treatment recorded; this was highest in patients with limited specialist input but accounted for only 1.7% of these patients.

Table 66: Bone tumour patient details by amount of specialist inpatient care

		Limited		Some		Mostly			
		n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	79	*65.8*	*23*	*53.5*	149	*53.6*	251	
	20-24	41	*34.2*	*20*	*46.5*	129	*46.4*	190	*0.07*
Gender	**Male**	71	*59.2*	*25*	*58.1*	176	*63.3*	272	
	Female	49	*40.8*	*18*	*41.9*	102	*36.7*	169	*0.65*
Diagnostic group	**Osteosarcona**	50	*41.7*	*20*	*46.5*	139	*50.0*	209	
	Ewing's sarcoma	50	*41.7*	*18*	*41.9*	100	*36.0*	168	
	Other bone tumour	20	*16.7*	*5*	*11.6*	39	*14.0*	64	*0.59*
Deprivation	**Most affluent**	19	*15.8*	*8*	*18.6*	54	*19.4*	81	
	4	25	*20.8*	*8*	*18.6*	39	*14.0*	72	
	3	23	*19.2*	*11*	*25.6*	39	*14.0*	73	
	2	23	*19.2*	*6*	*14.0*	48	*17.3*	77	
	Most deprived	28	*23.3*	*10*	*23.3*	78	*28.1*	116	
	Unknown	2	*1.7*	*0*	*0.0*	20	*7.2*	22	*0.47*
Alive at end of treatment	**Yes**	64	*53.3*	*20*	*46.5*	160	*57.6*	224	
	No	56	*46.7*	*23*	*53.5*	118	*42.4*	197	*0.35*
Treatment received	**Surgery**	18	*15.0*	*2*	*4.7*	32	*11.5*	52	
	Surgery & additonal therapy	78	*65.0*	*38*	*88.4*	197	*70.9*	313	
	Chemoradiotherapy	22	*18.3*	*2*	*4.7*	49	*17.6*	74	
	None	2	*1.7*	*0*	*0.0*	0	*0.0*	2	*0.06*
Total (number of patients)		120		43		278		441	

Table 67: Bone tumour patient details by type of specialist inpatient care

		Limited		Bone		TCT		Bone & TCT			
		n	%	n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	79	*65.8*	*32*	*55.2*	105	*55.3*	*35*	*47.9*	251	
	20-24	41	*34.2*	*26*	*44.8*	85	*44.7*	*38*	*52.1*	190	*0.09*
Gender	**Male**	71	*59.2*	*37*	*63.8*	115	*60.5*	*49*	*67.1*	272	
	Female	49	*40.8*	*21*	*36.2*	75	*39.5*	*24*	*32.9*	169	*0.69*
Diagnostic group	**Osteosarcona**	50	*41.7*	*30*	*51.7*	89	*46.8*	*40*	*54.8*	209	
	Ewing's sarcoma	50	*41.7*	*5*	*8.6*	88	*46.3*	*25*	*34.2*	168	
	Other bone tumour	20	*16.7*	*23*	*39.7*	13	*6.8*	*8*	*11.0*	64	*<0.01*
Deprivation	**Most affluent**	19	*15.8*	*7*	*12.1*	40	*21.1*	*15*	*20.5*	81	
	4	25	*20.8*	*9*	*15.5*	30	*15.8*	*8*	*11.0*	72	
	3	23	*19.2*	*10*	*17.2*	30	*15.8*	*10*	*13.7*	73	
	2	23	*19.2*	*7*	*12.1*	31	*16.3*	*16*	*21.9*	77	
	Most deprived	28	*23.3*	*8*	*13.8*	58	*30.5*	*22*	*30.1*	116	
	Unknown	2	*1.7*	*17*	*29.3*	1	*0.5*	*2*	*2.7*	22	*0.59*
Alive at end of treatment	**Yes**	64	*53.3*	*51*	*87.9*	90	*47.4*	*39*	*53.4*	244	
	No	56	*46.7*	*7*	*12.1*	100	*52.6*	*34*	*46.6*	197	*<0.01*
Treatment received	**Surgery**	18	*15.0*	*24*	*41.4*	6	*3.2*	*4*	*5.5*	52	
	Surgery & additonal therapy	78	*65.0*	*33*	*56.9*	141	*74.2*	*61*	*83.6*	313	
	Chemoradiotherapy	22	*18.3*	*1*	*1.7*	43	*22.6*	*8*	*11.0*	74	
	None	2	*1.7*	*0*	*0.0*	0	*0.0*	*0*	*0.0*	2	*<0.01*
Total (number of patients)		120		58		190		73		441	

9.4 Patient outcomes

9.4.1 Treatment received

The proportion of patients undergoing surgery alone varied by the amount of specialist care received, the smallest proportion being seen in those with some specialist input. This group also had the largest proportion of patients having surgery with additional therapy (Figure 54). Overall very few patients received no treatment; in fact this was only seen in patients with limited specialist input. The type of specialist care received also appeared to affect the treatment (Figure 55). Close to 100% of patients with bone specialist care underwent surgery, with or without additional therapy. Very few of those who had TCT specialist input, with or without additional therapy had surgery alone. Chemoradiotherapy without surgery was seen mainly in those with limited specialist input or TCT input only.

Figure 54: Treatment received, by amount of specialist care

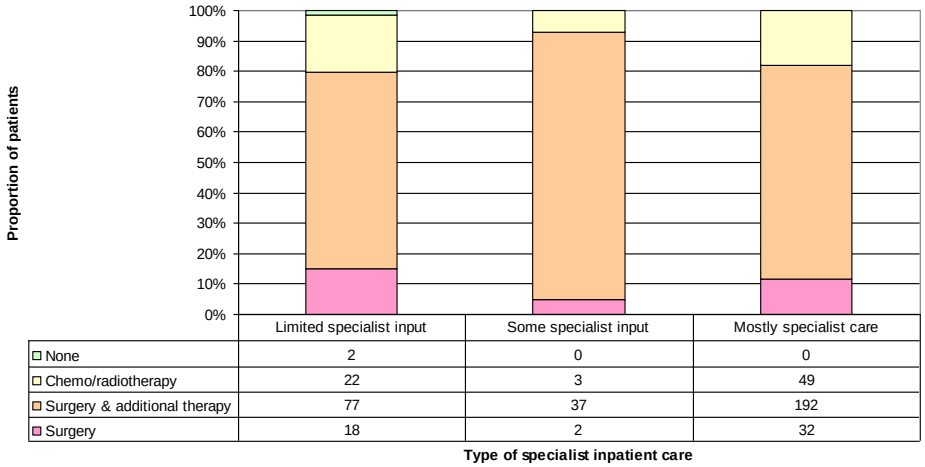
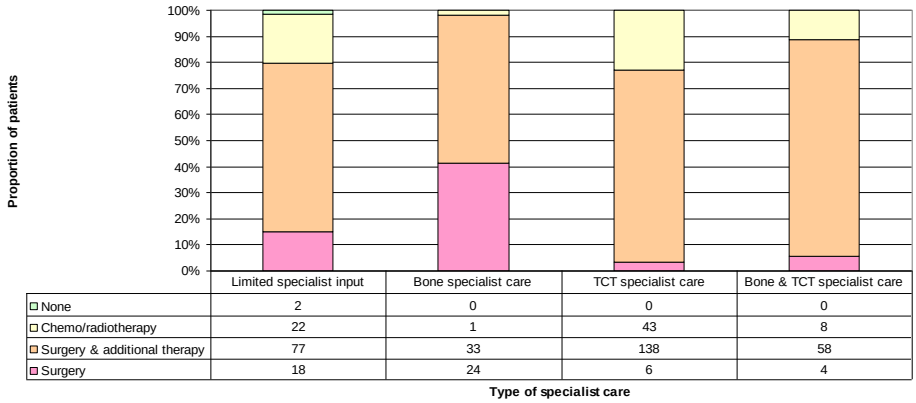


Figure 55: Treatment received, by type of specialist care



Time from diagnosis to first admission varied by type of specialist care received, with those patients with bone tumour specialist care having earlier admissions than any other remaining groups (Table 69). The median time from diagnosis to major surgical resection of their tumour was also shorter than any of the other groups. Variation by amount of specialist care was minimal (Table 68).

Table 68: Time from diagnosis to first treatment, by amount of specialist care (a negative value represents an event prior to diagnosis)

	Weeks from diagnosis to first admission		Weeks from diagnosis to first chemotherapy		Weeks from diagnosis to first radiotherapy		Weeks from diagnosis to first surgery	
	Median	Range	Median	Range	Median	Range	Median	Range
Limited specialist input	16	-4 - 75	4	-3 - 65	26	18 - 29	15	0 - 49
Some specialist input	15	-4 - 59	3	-3 - 32	29.5	20 - 39	16	-1 - 31
Mostly specialist care	18	-4 - 77	3	-3 - 58	31	1 - 36	14.5	-1 - 124

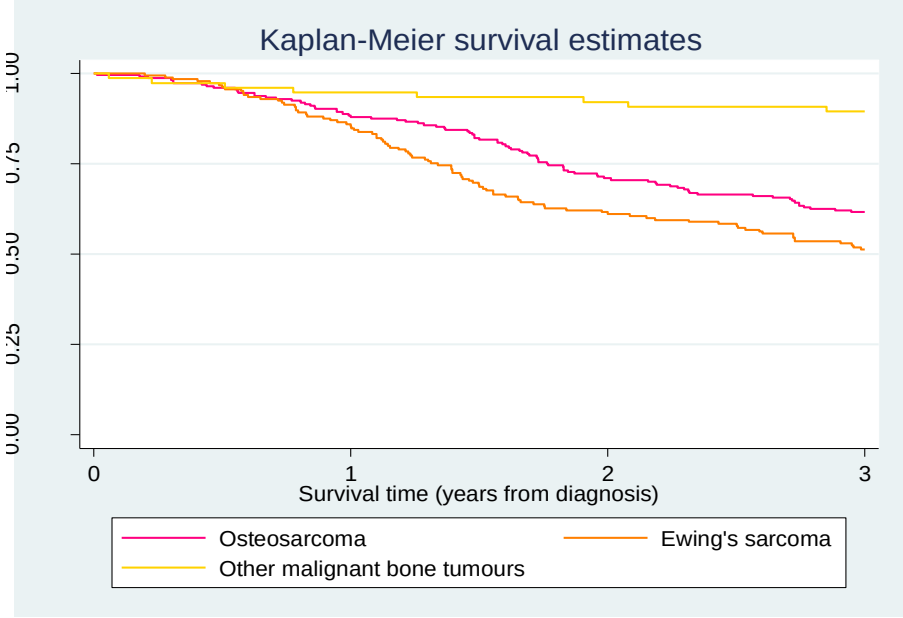
Table 69: Time from diagnosis to first treatment, by type of specialist care (a negative value represents an event prior to diagnosis)

	Weeks from diagnosis to first admission		Weeks from diagnosis to first chemotherapy		Weeks from diagnosis to first radiotherapy		Weeks from diagnosis to first surgery	
	Median	Range	Median	Range	Median	Range	Median	Range
Limited specialist input	16	-4 - 75	4	-3 - 65	26	18 - 29	15	0 - 49
Bone specialist care	7	-4 - 75	9.5	2 - 32	-	- - -	5	-1 - 84
TCT specialist care	19	-3 - 77	3	-3 - 58	30	1 - 39	16	-1 - 124
Bone & TCT specialist care	16	-4 - 76	3	0 - 57	31	31 - 31	15	0 - 77

9.4.2 Survival

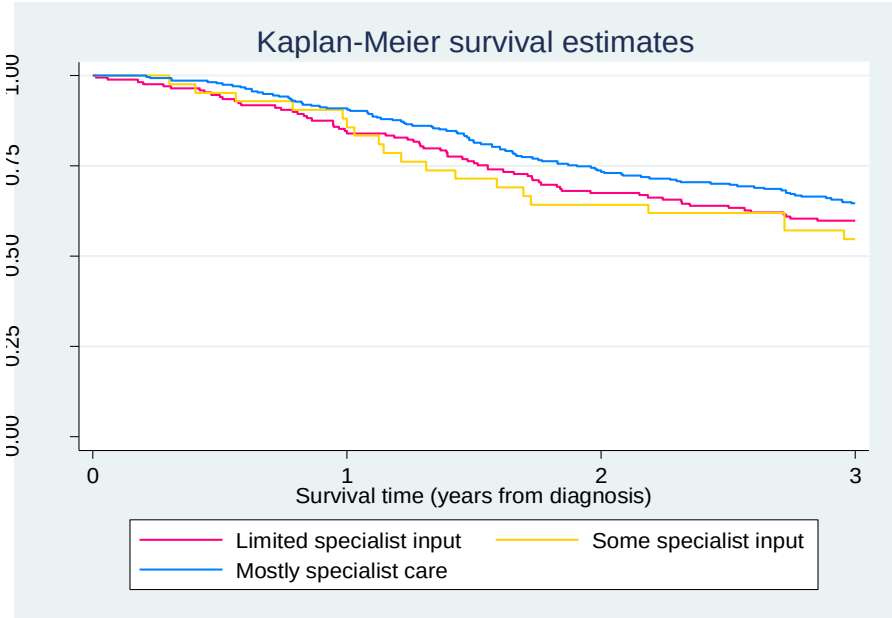
The three diagnostic groups assessed showed largely different survival curves with those being diagnosed with Ewing's sarcoma of the bone fairing worst, with 50% surviving to three years. Osteosarcoma patients had better survival with 60% surviving to three years. 'Other' malignant bone tumours had the greatest overall survival (Figure 56).

Figure 56: Survival to three years from diagnosis, by diagnostic subtype of bone tumour



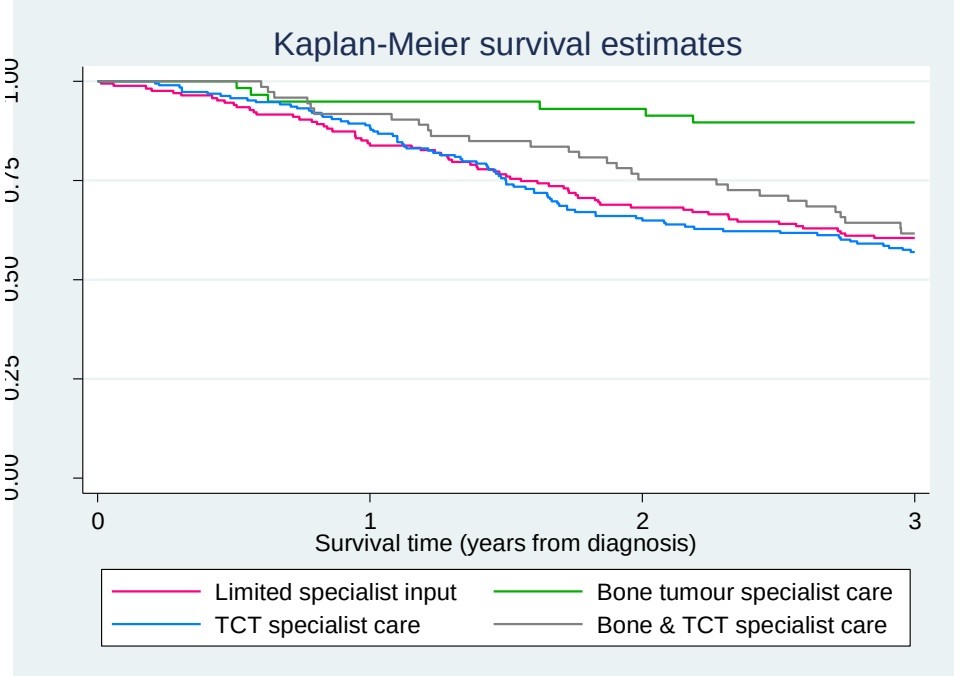
The poorest survival was seen in those who received some specialist input, with those with limited specialist care faring better and those who had mostly specialist care having the best survival to three years (Figure 57).

Figure 57: Survival to three years by amount to specialist care received, bone tumour patients



Those who received bone tumour specialist care had the best survival to three years, patients who were admitted to a TCT unit, with or without the involvement of a bone tumour centre, showed poorer survival. This suggests that those who are admitted to a bone tumour centre only may have less aggressive, earlier stage disease which did not require systemic treatment and therefore did not require admission for chemo/radiotherapy (Figure 58).

Figure 58: Survival to three years from diagnosis by type of specialist inpatient care, bone tumours



The proportional hazards test for the proposed Cox proportional hazards model for bone tumours demonstrated that each variable was non-statistically significant, as was the global test (Table 70). Meaning that the proportional hazards assumption held and the model could be used. There was no evidence to suggest that the inclusion of age as a categorical variable resulted in a better fit than when age was modelled continuously (p=0.70) and so the latter method was chosen.

Table 70: Results of the proportional hazards test (stphtest)

		rho	χ2	Prob> χ2
Age at diagnosis		0.06	0.57	*0.45*
Gender	**Male**	1.00		
	Female	0.04	0.27	*0.61*
Year of diagnosis		-0.08	1.13	*0.29*
Deprivation	**1 (Most deprived)**	1.00		
	2	0.00	0.00	*1.00*
	3	0.02	0.07	*0.79*
	4	-0.03	0.16	*0.69*
	5 (Most affluent)	-0.01	0.04	*0.85*
Diagnostic subgroup	**Osteosarcoma**	1.00		
	Ewing's sarcoma	-0.06	0.55	*0.46*
	Other malignant bone tumours	-0.03	0.19	*0.67*
Amount of specialist care	**Limited**	1.00		
	Some	-0.01	0.01	*0.94*
	Mostly			
Type of specialist care	**Limited**	1.00		
	Bone	-0.03	0.18	*0.67*
	TCT	0.00	0.00	*0.97*
	Bone & TCT	0.12	2.31	*0.13*
Global test			6.83	*0.92*

A diagnosis of 'other malignant bone tumours' had a statistically significant beneficial effect, with this diagnostic group having a 74% decreased risk of death compared to those diagnosed with osteosarcoma (HR 0.26 95%CI 0.11-0.61) . Receiving mostly specialist care had the same risk associated with it as receiving limited specialist care only, whereas having some specialist care led to a statistically significant increased risk of death (increase of 76%) (HR 1.76 95%CI 1.05-2.96). Receiving bone tumour specialist care was linked to a decrease in risk of death of 91%, this was a statistically significant result (HR 0.09 95%CI 0.02-0.39). Both TCT and bone & TCT specialist care were also associated with a decreased risk of death but this was non-significant (Table 71).

Table 71: Cox regression model for bone tumours

				Confidence intervals	
		Haz. Ratio	*p value*	Lower 95%	Upper 95%
Age at diagnosis		1.03	*0.35*	0.97	1.09
Gender	**Male**	1.00			
	Female	1.02	*0.89*	0.74	1.41
Year of diagnosis		0.95	*0.23*	0.86	1.04
Deprivation	**Most deprived**	1.00			
	2	1.00	*1.00*	0.64	1.58
	3	0.80	*0.36*	0.49	1.30
	4	0.65	*0.11*	0.38	1.10
	Most affluent	1.19	*0.44*	0.77	1.83
Diagnostic subgroup	**Osteosarcoma**	1.00			
	Ewing's sarcoma	1.29	*0.12*	0.94	1.77
	Other malignant bone tumours	0.26	*<0.01*	0.11	0.61
Amount of specialist care	**Limited**	1.00			
	Some	1.76	*0.03*	1.05	2.96
	Mostly	1.00			
Type of specialist care	**Limited**	1.00			
	Bone	0.09	*<0.01*	0.02	0.39
	TCT	0.81	*0.27*	0.56	1.17
	Bone & TCT	0.73	*0.19*	0.45	1.17

9.4.3 Health service usage

The peak in admissions for bone tumour patients occurred at the same time from diagnosis regardless of the amount of specialist care (Figure 59). However when assessed by the type of specialist care the peak in admissions for patients with bone & TCT input showed a slower decline than that seen in any other age group (Figure 60).

Figure 59: Number of admissions per week, by time from diagnosis and amount of specialist care

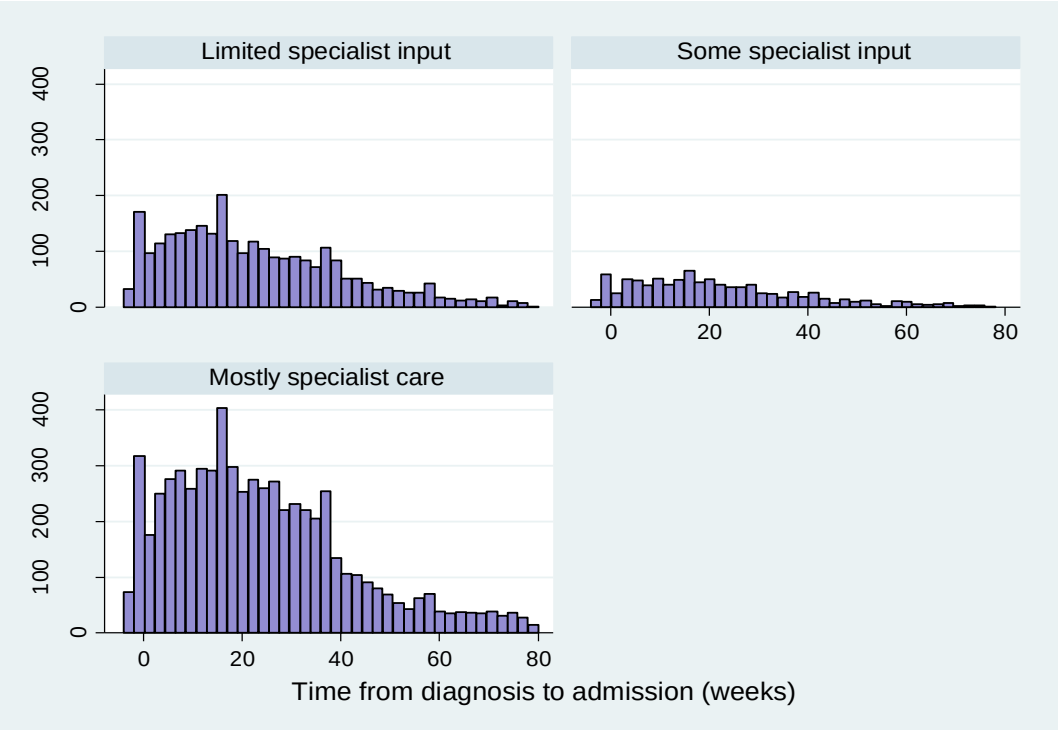
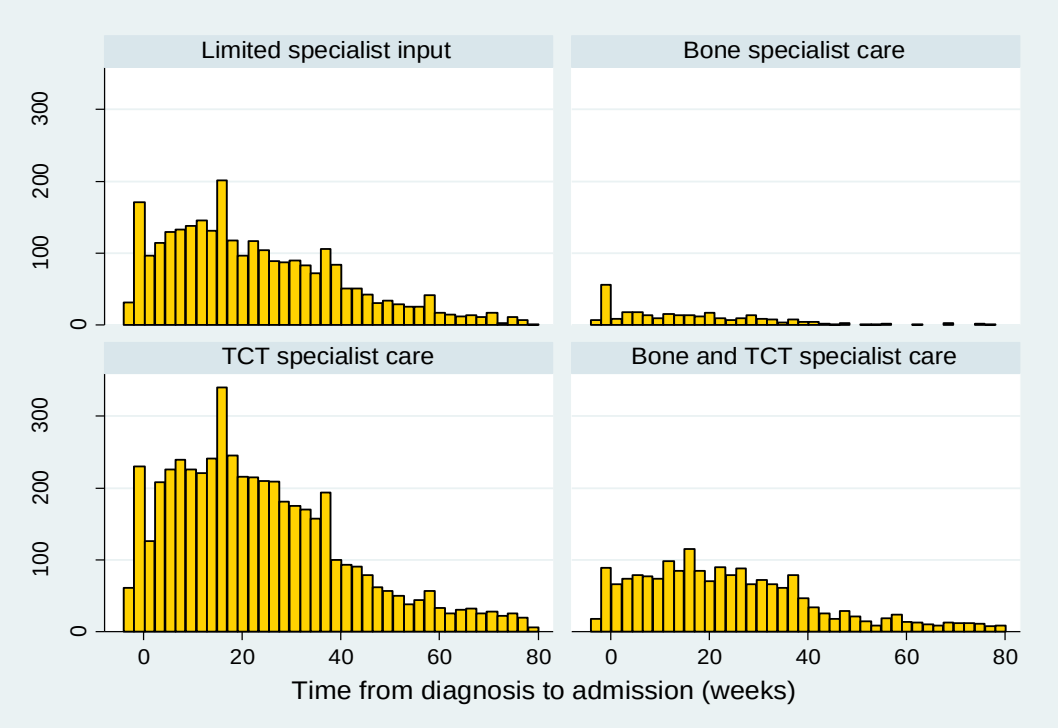


Figure 60: Number of admissions per week, by time from diagnosis and type of specialist care



The median number of admissions (Figure 61) showed little variation by amount of specialist care received, those with mostly specialist care had slightly fewer admissions. The same pattern was seen when examining the proportion of admissions which were unplanned (Figure 62). Similarly there was little variation across groups for the proportion of the treatment

period (Figure 63), but those with limited specialist input spent less of this time period as an inpatient.

Patients receiving only bone tumour specialist care had fewer admissions during treatment (Figure 61) and spent a smaller proportion of the treatment period as an inpatient (Figure 63), however a greater proportion of admissions for this group were unplanned than for any other type of specialist care (Figure 62). Patients receiving both bone and TCT specialist inpatient care spent the greatest proportion of the treatment period as an inpatient of any diagnostic group.

Figure 61: Median number of admissions per patient during treatment

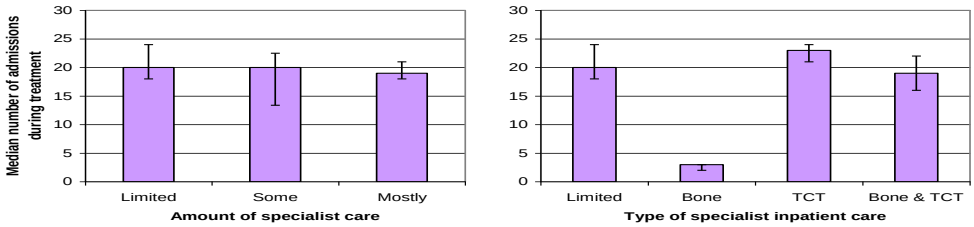


Figure 62: Median proportion of admissions per patient during treatment, which were unplanned

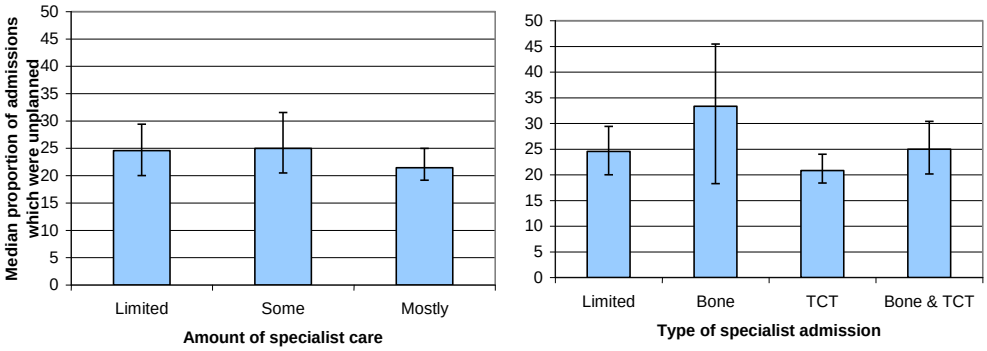
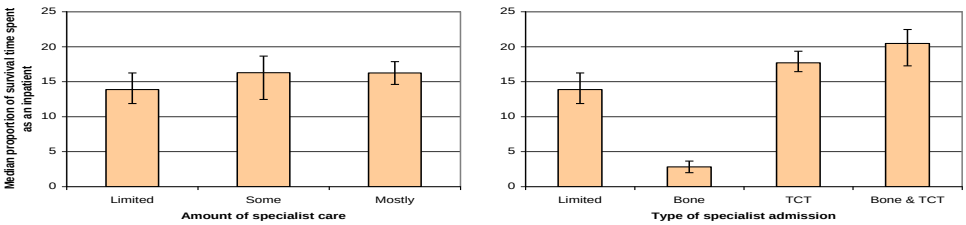


Figure 63: Median proportion of the treatment period spent as in inpatient, per patient



9.4.4 Health service costs

Patients with limited specialist inpatient care had a lower total cost of admission during treatment than patients with any other amount of specialist input (Figure 64). This pattern was repeated for patients with bone tumour related specialist inpatient care; however this is reflective of the fact that they had the lowest median number of admissions during treatment of any type of specialist care. In order to address this, median cost per admission was calculated for each group (Figure 65). The patients receiving mostly specialist care had the

highest cost per admission and in the reverse of the pattern seen for total cost; patients with bone tumour specialist care had the highest cost per admission.

Figure 64: Median cost of admissions during treatment, per patient

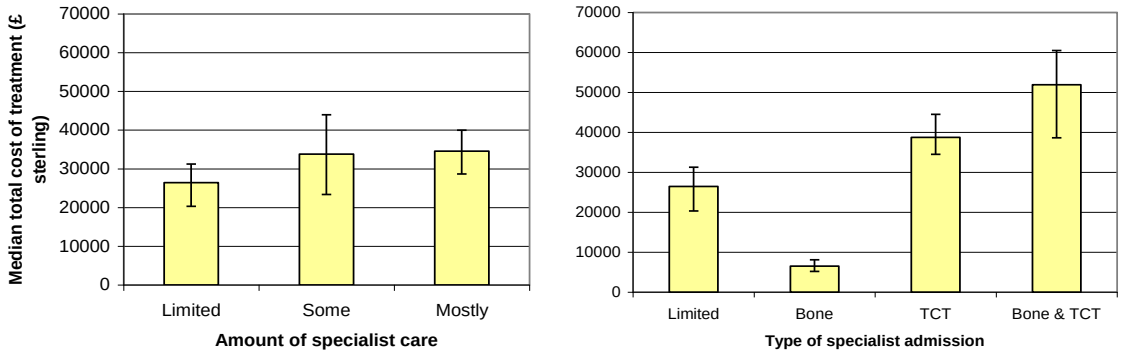
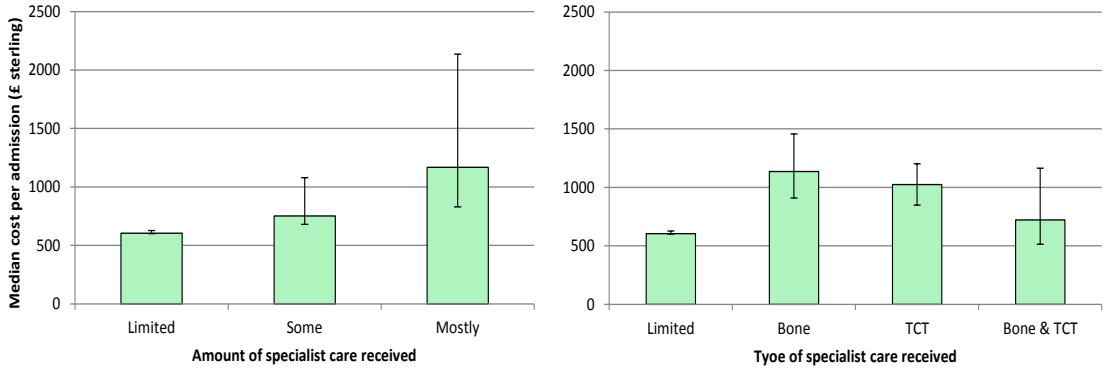


Figure 65: Median cost per admission

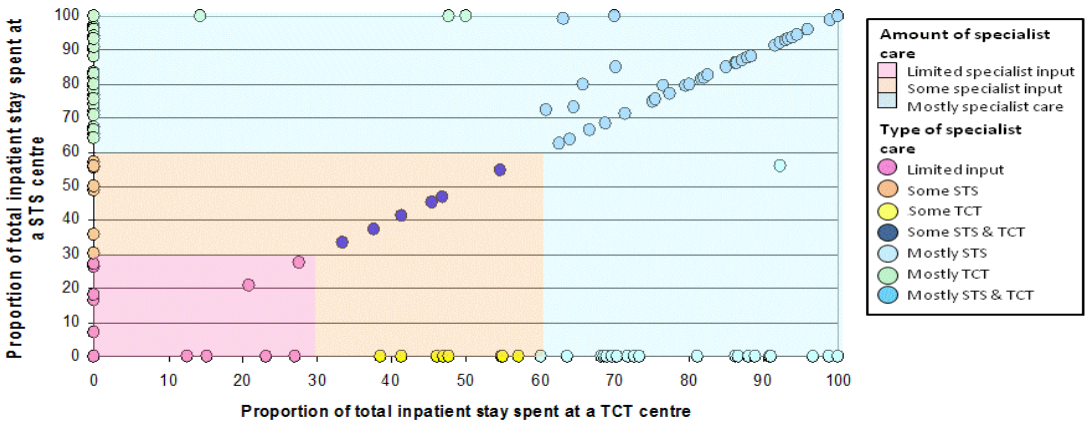


Chapter 10 Soft tissue sarcoma

10.1 Specialist care

Some forms of soft tissue sarcoma may be treated at specialist centres dependent on the type and location of tumour. In order to incorporate such specialist care in the analysis both STS centres and TCT centres were deemed as specialist centres. In order to determine what proportion of specialist care each patient received, therefore, the amount of care received in an STS centre was compared to the proportion spent in a TCT centre.

Figure 66: Assignment of STS patients to a "level" of specialist care using the proportion of inpatient time spent in a specialist centre



10.2 Access to specialist care

10.2.1 Hospital catchment areas

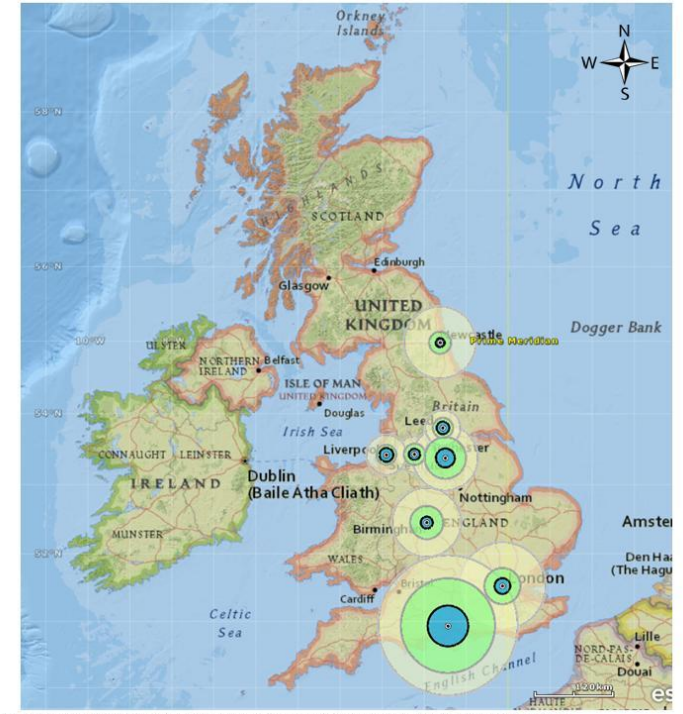
As previously mentioned STS patients may be treated at both STS and TCT centres. Firstly, therefore, access to TCT centres was assessed, followed by access to STS centres.

Amongst the TCT centres Alder Hey, the Christie and Sheffield had larger catchment areas than anticipated (Map 16 and Map 17) whereas Southampton, Birmingham and Leeds had smaller. Newcastle and UCL had very similar actual and predicted catchment areas.

Southampton, UCL and Sheffield had the greatest proportion of patients, for whom they were the closest centre, who were not admitted to a TCT centre during their treatment (Table 72). In contrast 96% (24 out of 25 patients) who live the closest to Leeds were admitted to Leeds. Newcastle had similarly low numbers of patients with no TCT admissions during treatment

(four out of 32 patients). Very few patients were admitted to a centre other than their closest one.

Map 17: Site of TCT centres in England (2001-2009) and the residential location of STS patients closest to each



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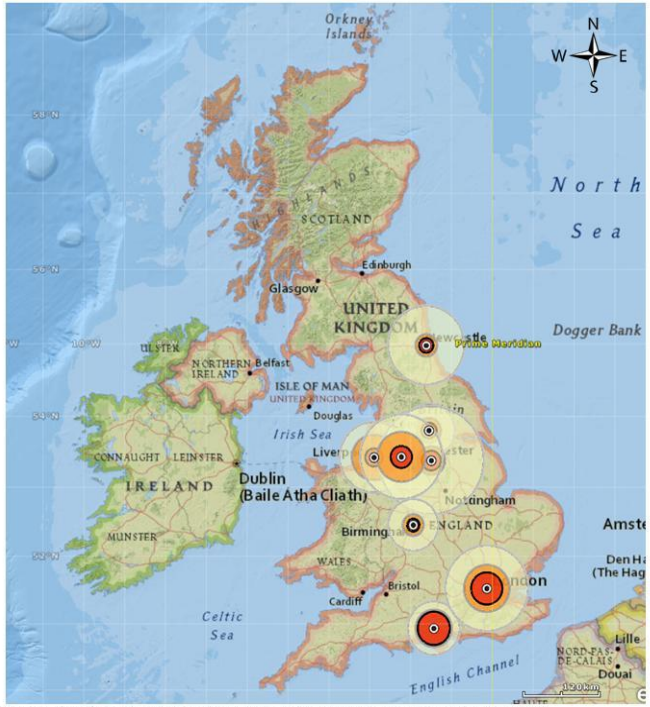
Key
Location of TCT centres
Proportion of STS tumour patients
25% of cases
50% of cases
75% of cases

Map 16: Site of TCT centres in England (2001-2009) and the residential location of STS patients admitted to each



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Key
Location of TCT centres
Proportion of STS patients
25% of cases
50% of cases
75% of cases

Table 72: Numbers of STS patients closest to each TCT centre, and the centre actually attended

		NHS trust with a TCT unit to which the patient was admitted																		
		Alder Hey Children's NHS Foundation Trust		Leeds Teaching Hospitals NHS Trust		Sheffield Teaching Hospitals NHS Foundation Trust		University Hospital Southampton NHS Foundation Trust		The Christie NHS Foundation Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		University College London Hospitals NHS Foundation Trust		University Hospitals Birmingham NHS Foundation Trust		None		Total
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Closest NHS trust with a TCT unit at the time of admission	Alder Hey Children's NHS Foundation Trust	**5**	*19*	**0**	*0*	**1**	*3.7*	**0**	*0*	**5**	*19*	**1**	*3.7*	**0**	*14*	**0**	*0*	**15**	*56*	**27**
	Leeds Teaching Hospitals NHS Trust	**0**	*0*	**24**	*96*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*4*	**25**
	Sheffield Teaching Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**7**	*26*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**20**	*74*	**27**
	University Hospital Southampton NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**12**	*22*	**0**	*0*	**1**	*1.9*	**1**	*3.4*	**1**	*1.9*	**39**	*72*	**54**
	The Christie NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**16**	*53*	**0**	*0*	**0**	*0*	**1**	*3.3*	**13**	*43*	**30**
	The Newcastle upon Tyne Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**28**	*88*	**0**	*273*	**0**	*0*	**4**	*13*	**32**
	University College London Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**34**	*12*	**0**	*0*	**81**	*70*	**115**
	University Hospitals Birmingham NHS Foundation Trust	**0**	*0*	**0**	*0*	**1**	*1.9*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*0*	**26**	*48*	**26**	*48*	**54**
	Total	**5**		**24**		**9**		**12**		**21**		**30**		**36**		**28**		**199**		**364**

Increasing road travel distance decreased the odds of admission to a TCT unit by 8% for every 5km (OR 0.92 95%CI 0.89-0.96). A diagnosis of rhabdomyosarcoma or unspecified STS both significantly increased the odds of admission to a TCT centre (Table 73). Patients with rhabdomyosarcoma were 90% more likely to be admitted to a TCT centre than patients with fibrosarcoma (OR 1.90 95%CI 1.09-3.34), patients with unspecified STS were 28% more likely to be admitted than fibrosarcoma patients, however this was not statistically significant. Each single year increase in age at diagnosis was associated with an 11% increased likelihood of admission to a TCT centre (OR 1.11 95%CI 1.02-1.21).

Table 73: Likelihood of admission to a TCT centre for STS patients

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	1.00	0.98	0.64	1.59
Age at diagnosis		1.11	0.02	1.02	1.21
Diagnostic group	Fibrosarcoma	0.23	<0.01	0.10	0.54
	Rhabdomyosarcoma	1.90	0.03	1.09	3.34
	Other	1.00			
	Unspecified	1.28	0.42	0.70	2.36
Deprivation	Most deprived	1.00			
	2	0.69	0.26	0.36	1.31
	3	1.03	0.93	0.54	1.95
	4	0.64	0.22	0.31	1.31
	Most affluent	0.59	0.15	0.28	1.22
Distance to nearest TCT centres (increase of 5km)		0.92	<0.01	0.89	0.96

When examining the distribution of patients around STS specialist centres mapping was not possible in the same way seen for TCT centres due to the large number of centres and small number of patients. However it was possible to examine the number of patients attending their closest STS specialist centre according to road travel distance (Table 74). In all cases the majority of patients were either admitted to their closest trust or were not admitted to a STS specialist centre during treatment. The proportion of patients admitted to each trust ranged from 93.3% (Newcastle) to 18.8% (The Royal National Orthopaedic Hospital).

Table 74: Numbers of STS patients closest to each STS centre, and the centre actually attended

Closest STS centre at the time of admission	NHS trust to which the patient was admitted (STS centres): Cambridge University Hospitals NHS Foundation Trust		The Christie NHS Foundation Trust		Oxford University Hospitals NHS Trust		Plymouth Hospitals NHS Trust		Bristol Sarcoma Service		University Hospitals of Leicester NHS Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		Nottingham University Hospitals NHS Trust		Robert Jones and Agnes Hunt Orthopaedic Hospital NHS Foundation Trust		Royal National Orthopaedic Hospital NHS Trust		The Royal Orthopaedic Hospital NHS Foundation Trust		Royal Devon and Exeter NHS Foundation Trust		Royal Liverpool and Broadgreen University Hospitals NHS Trust		The Royal Marsden NHS Trust		Leeds Teaching Hospitals NHS Trust		Sheffield Teaching Hospitals NHS Foundation Trust		None		Total
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Cambridge University Hospitals NHS Foundation Trust	13	48.1	0	0.0	1	3.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6	22.2	2	7.4	0	0.0	0	0.0	2	7.4	0	0.0	0	0.0	3	11.1	27
The Christie NHS Foundation Trust	0	0.0	16	57.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.6	0	0.0	5	17.9	0	0.0	0	0.0	0	0.0	1	3.6	0	0.0	5	17.9	28
Oxford University Hospitals NHS Trust	0	0.0	0	0.0	11	68.8	1	6.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	6.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	18.8	16
Plymouth Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	5	62.5	1	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	12.5	0	0.0	0	0.0	1	12.5	8
Bristol Sarcoma Service	0	0.0	0	0.0	0	0.0	0	0.0	5	29.4	0	0.0	0	0.0	0	0.0	0	0.0	2	11.8	4	23.5	0	0.0	0	0.0	1	5.9	0	0.0	0	0.0	5	29.4	17
University Hospitals of Leicester NHS Trust	1	6.3	0	0.0	0	0.0	0	0.0	0	0.0	6	37.5	0	0.0	0	0.0	0	0.0	1	6.3	5	31.3	0	0.0	0	0.0	1	6.3	0	0.0	1	6.3	1	6.3	16
The Newcastle upon Tyne Hospitals NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	28	93.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	6.7	30
Nottingham University Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	8.7	0	0.0	13	56.5	0	0.0	0	0.0	7	30.4	0	0.0	0	0.0	1	4.3	0	0.0	0	0.0	0	0.0	23
Robert Jones and Agnes Hunt Orthopaedic Hospital NHS Foundation Trust	0	0.0	1	33.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	66.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3
Royal National Orthopaedic Hospital NHS Trust	2	12.5	0	0.0	1	6.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	18.8	0	0.0	0	0.0	0	0.0	2	12.5	0	0.0	0	0.0	8	50.0	16
The Royal Orthopaedic Hospital NHS Foundation Trust	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	34	82.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5	12.2	41
Royal Devon and Exeter NHS Foundation Trust	0	0.0	0	0.0	0	0.0	1	10.0	2	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	10.0	5	50.0	0	0.0	0	0.0	0	0.0	0	0.0	1	10.0	10
Royal Liverpool and Broadgreen University Hospitals NHS Trust	0	0.0	4	16.0	0	0.0	0	0.0	0	0.0	0	0.0	2	8.0	0	0.0	1	4.0	0	0.0	3	12.0	0	0.0	9	36.0	0	0.0	0	0.0	1	4.0	5	20.0	25
The Royal Marsden NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	8	13.3	0	0.0	0	0.0	0	0.0	27	45.0	0	0.0	0	0.0	25	41.7	60
Leeds Teaching Hospitals NHS Trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.4	0	0.0	0	0.0	0	0.0	0	0.0	2	6.9	0	0.0	0	0.0	1	3.4	24	82.8	0	0.0	1	3.4	29
Sheffield Teaching Hospitals NHS Foundation Trust	0	0.0	0	0.0	1	6.7	0	0.0	0	0.0	0	0.0	0	0.0	2	13.3	0	0.0	0	0.0	3	20.0	0	0.0	0	0.0	0	0.0	0	0.0	7	46.7	2	13.3	15
Total	16		21		14		7		9		10		30		15		4		21		66		5		9		36		25		9		67		364

Table 75: Likelihood of admission to a STS specialist centre

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	0.78	0.25	0.51	1.20
Age at diagnosis		1.03	0.52	0.95	1.11
Diagnostic group	Fibrosarcoma	0.47	0.01	0.25	0.85
	Rhabdomyosarcoma	2.51	<0.01	1.40	4.49
	Other	1.00			
	Unspecified	0.74	0.33	0.41	1.35
Deprivation	Most deprived	1.00			
	2	1.57	0.16	0.84	2.94
	3	1.26	0.49	0.66	2.38
	4	1.51	0.21	0.79	2.91
	Most affluent	1.52	0.23	0.76	3.05
Distance to nearest TCT centres (increase of 5km)		0.90	<0.01	0.87	0.93

As with admissions to a TCT centre, an increasing distance from the place of residence to the STS specialist centre decreased the odds of being admitted there (OR 0.90 95%CI 0.87-0.93) (Table 75). Likewise, a diagnosis of fibrosarcoma or unspecified STS compared to 'other' STS decreased the odds of admission to a specialist STS centre. In contrast a diagnosis of rhabdomyosarcoma was associated with a greater than two fold increase of likelihood of admission to an STS specialist centre (OR 2.51 95%CI 1.40-4.49).

10.2.2 Geographical distribution of patients

In 13 of the 31 cancer networks the majority of patients received limited TCT and STS specialist inpatient care. In the Lancashire and South Cumbria network area the majority of patients received "some" specialist inpatient care. South West London showed an equal distribution between "limited input", "some" and "mostly" specialist care, Kent and Medway showed an equal split between "some" and "mostly". In the remaining 18 networks the majority of patients received mostly specialist inpatient care (Table 76).

Table 76: Cancer network of residence at diagnosis and level of specialist inpatient care, STS (highlighted sections represent the highest proportion of patients for each cancer network)

	Limited		Some		Mostly		Number of patients
	n	%	n	%	n	%	
Lancashire & South Cumbria	2	28.6	3	42.9	2	28.6	7
Greater Manchester & Cheshire	9	39.1	1	4.3	13	56.5	23
Merseyside & Cheshire	9	47.4	1	5.3	9	47.4	19
Yorkshire	2	9.5	0	0.0	19	90.5	21
Humber & Yorskhire Coast	2	40.0	0	0.0	3	60.0	5
North Trent	8	57.1	1	7.1	5	35.7	14
Pan Birmingham	5	25.0	0	0.0	15	75.0	20
Arden	3	60.0	0	0.0	2	40.0	5
Mid Trent	1	9.1	0	0.0	10	90.9	11
Derby/ Burton	1	33.3	0	0.0	2	66.7	3
Leicestershire, Northants & Rutland	3	33.3	0	0.0	6	66.7	9
Mount Vernon	2	33.3	1	16.7	3	50.0	6
West London	7	53.8	0	0.0	6	46.2	13
North London	3	33.3	1	11.1	5	55.6	9
North East London	4	44.4	0	0.0	5	55.6	9
South East London	3	30.0	1	10.0	6	60.0	10
South West London	3	33.3	3	33.3	3	33.3	9
Peninsula	3	25.0	0	0.0	9	75.0	12
Dorset	3	75.0	1	25.0	0	0.0	4
Avon, Somerest & Wiltshire	8	61.5	1	7.7	4	30.8	13
3 Counties	3	42.9	0	0.0	4	57.1	7
Thames Valley	13	76.5	2	11.8	2	11.8	17
Central South Coast	16	94.1	0	0.0	1	5.9	17
Surrey, West Sussex & Hampshire	1	20.0	0	0.0	4	80.0	5
Sussex	5	62.5	1	12.5	2	25.0	8
Kent & Medway	2	25.0	3	37.5	3	37.5	8
Greater Midlands	6	50.0	1	8.3	5	41.7	12
North of England	35	100.0	0	0.0	0	0.0	35
Anglia	4	20.0	2	10.0	14	70.0	20
Essex	3	60.0	0	0.0	2	40.0	5
Wales	3	60.0	0	0.0	2	40.0	5
Unknown	1	33.3	0	0.0	2	66.7	3
Total	173	47.5	23	6.3	168	46.2	364

In seven networks the majority of patients received a combination of STS and TCT specialist inpatient care, in eight networks the bulk of the specialist input consisted of STS care and in four cases it was TCT alone. North London demonstrated an equal distribution between "limited" specialist input, TCT specialist care and STS specialist care (Table 77).

Table 77; Cancer network of residence at diagnosis and type of specialist inpatient care, STS (highlighted sections represent the highest proportion of patients for each cancer network)

	Limited		TCT		STS		STS & TCT		Number of patients
	n	%	n	%	n	%	n	%	
Lancashire & South Cumbria	2	28.6	0	0.0	0	0.0	5	71.4	7
Greater Manchester & Cheshire	9	39.1	1	4.3	4	17.4	9	39.1	23
Merseyside & Cheshire	9	47.4	2	10.5	7	36.8	1	5.3	19
Yorkshire	2	9.5	0	0.0	1	4.8	18	85.7	21
Humber & Yorskhire Coast	2	40.0	0	0.0	0	0.0	3	60.0	5
North Trent	8	57.1	0	0.0	2	14.3	4	28.6	14
Pan Birmingham	5	25.0	0	0.0	0	0.0	15	75.0	20
Arden	3	60.0	0	0.0	0	0.0	2	40.0	5
Mid Trent	1	9.1	0	0.0	10	90.9	0	0.0	11
Derby/ Burton	1	33.3	0	0.0	2	66.7	0	0.0	3
Leicestershire, Northants & Rutland	3	33.3	1	11.1	5	55.6	0	0.0	9
Mount Vernon	2	33.3	3	50.0	1	16.7	0	0.0	6
West London	7	53.8	4	30.8	2	15.4	0	0.0	13
North London	3	33.3	3	33.3	3	33.3	0	0.0	9
North East London	4	44.4	4	44.4	1	11.1	0	0.0	9
South East London	3	30.0	1	10.0	6	60.0	0	0.0	10
South West London	3	33.3	2	22.2	4	44.4	0	0.0	9
Peninsula	3	25.0	0	0.0	9	75.0	0	0.0	12
Dorset	3	75.0	1	25.0	0	0.0	0	0.0	4
Avon, Somerest & Wiltshire	8	61.5	0	0.0	5	38.5	0	0.0	13
3 Counties	3	42.9	0	0.0	0	0.0	4	57.1	7
Thames Valley	13	76.5	4	23.5	0	0.0	0	0.0	17
Central South Coast	16	94.1	0	0.0	1	5.9	0	0.0	17
Surrey, West Sussex & Hampshire	1	20.0	0	0.0	4	80.0	0	0.0	5
Sussex	5	62.5	0	0.0	3	37.5	0	0.0	8
Kent & Medway	2	25.0	4	50.0	2	25.0	0	0.0	8
Greater Midlands	6	50.0	0	0.0	0	0.0	6	50.0	12
North of England	35	100.0	0	0.0	0	0.0	0	0.0	35
Anglia	4	20.0	2	10.0	13	65.0	1	5.0	20
Essex	3	60.0	1	20.0	1	20.0	0	0.0	5
Wales	3	60.0	0	0.0	0	0.0	2	40.0	5
Unknown	1	33.3	0	0.0	1	33.3	1	33.3	3
Total	173	47.5	33	9.1	87	23.9	71	19.5	364

10.2.3 High volume centres

Nine of the trusts ranked in the top 15 in terms of numbers of STS patients were STS specialist centres. Four of the centres were both STS and TYA specialist centres (Newcastle, Birmingham, Leeds and the Christie). Both UCL and Southampton were TYA specialist centres and the remainder were neither (Table 78).

The Christie ranked 7th in terms of patient numbers but 1st in terms of admissions. St George's Healthcare NHS Trust was ranked 11th in terms of patients, North Bristol was 13th as was the University of South Manchester NHS Trust. None of these ranked amongst the top 15 in terms of number of admissions. Alder Hey, Lancashire, Sheffield and James Paget NHS Trusts were seen in the top 15 for number of admissions, but did not appear in the top 15 for patient numbers.

Table 78: Number of STS patients admitted to each NHS trust during the treatment period (top 15 only)

Rank	NHS Trust	Number of patients n	%
1	The Royal Marsden NHS Foundation Trust	34	*9.1*
1	The Royal Orthopaedic Hospital NHS Foundation Trust	34	*9.1*
3	University College London Hospitals NHS Trust	33	*8.8*
4	The Newcastle upon Tyne Hospitals NHS Foundation Trust	30	*8.0*
5	University Hospitals Birmingham NHS Foundation Trust	29	*7.7*
6	Leeds Teaching Hospitals NHS Trust	24	*6.4*
7	Royal National Orthopaedic Hospital NHS Foundation Trust	20	*5.3*
7	The Christie NHS Foundation Trust	20	*5.3*
9	Cambridge University Hospitals NHS Foundation Trust	14	*3.7*
10	Nottingham University Hospitals NHS Trust	13	*3.5*
11	University Hospital Southampton NHS Trust	12	*3.2*
11	St George's Healthcare NHS Trust	12	*3.2*
13	North Bristol NHS Trust	10	*2.7*
13	University Hospital of South Manchester NHS Trust	10	*2.7*
15	Central Manchester University Hospitals NHS Foundation Trust	9	*2.4*
15	University Hospitals Bristol NHS Foundation Trust	9	*2.4*
15	Royal Liverpool and Broadgreen University Hospitals NHS Trust	9	*2.4*
	Total number of patients	364	

STS centre
TCT centre
Both

Table 79: Number of admissions to each NHS trust during the treatment period, STS patients

Rank	NHS Trust	Number of admissions n	%
1	The Christie NHS Foundation Trust	470	*10.7*
2	The Royal Marsden NHS Foundation Trust	439	*10.0*
3	The Newcastle upon Tyne Hospitals NHS Foundation Trust	423	*9.6*
4	University College London Hospitals NHS Trust	320	*7.3*
5	Leeds Teaching Hospitals NHS Trust	268	*6.1*
6	University Hospitals Birmingham NHS Foundation Trust	254	*5.8*
7	Nottingham University Hospitals NHS Trust	187	*4.2*
8	University Hospital Southampton NHS Trust	181	*4.1*
9	University Hospitals Bristol NHS Foundation Trust	163	*3.7*
10	Cambridge University Hospitals NHS Foundation Trust	146	*3.3*
11	The Royal Orthopaedic Hospital NHS Foundation Trust	97	*2.2*
12	Alder Hey Children's Hospital NHS Foundation Trust	71	*1.6*
13	Lancashire Teaching Hospitals NHS Foundation Trust	60	*1.4*
14	Sheffield Teaching Hospitals NHS Foundation Trust	58	*1.3*
15	James Paget University Hospitals NHS Foundation Trust	53	*1.2*
	Total number of admissions	4,402	

STS centre
TCT centre
Both

10.3 Variation in the uptake of specialist care

Overall the majority of patients diagnosed with STS were aged 20 to 24 at diagnosis. This was reflected in patients with limited specialist input and those with mostly specialist care (Table 80), the opposite was true for patients with some specialist input. Patients with STS specialist care followed the overall pattern whilst those with TCT input were predominantly from the younger age group (Table 81).

The gender distribution was the same across all specialist care groups, with the majority of patients being male (Table 80 & Table 81).

Surgery alone was more common in those with limited specialist input than any other specialist group. Surgery in combination with chemo/radiotherapy was more commonly seen in patients with either some specialist input (Table 80) or in those with TCT specialist inpatient

care (Table 81). The proportion of patients with no treatment recorded was lowest in those with both STS and TCT specialist inpatient care (Table 81).

Table 80: STS patient details by amount of specialist inpatient care

		Limited		Some		Mostly			
		n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	74	*42.8*	*14*	*60.9*	74	*44.0*	162	
	20-24	99	*57.2*	*9*	*39.1*	94	*56.0*	202	*0.26*
Gender	**Male**	88	*50.9*	*15*	*65.2*	93	*55.4*	196	
	Female	85	*49.1*	*8*	*34.8*	75	*44.6*	168	*0.37*
Diagnostic group	**Fibrosarcoma**	45	*26.0*	*0*	*0.0*	23	*13.7*	68	
	Rhabdomyosarcoma	19	*11.0*	*9*	*39.1*	53	*31.5*	81	
	Other specified STS	81	*46.8*	*11*	*47.8*	61	*36.3*	153	
	Unspecified	28	*16.2*	*3*	*13.0*	31	*18.5*	62	*<0.01*
Deprivation	**Most affluent**	23	*13.3*	*3*	*13.0*	24	*14.3*	50	
	4	35	*20.2*	*0*	*0.0*	33	*19.6*	68	
	3	32	*18.5*	*9*	*39.1*	33	*19.6*	74	
	2	33	*19.1*	*6*	*26.1*	38	*22.6*	77	
	Most deprived	46	*26.6*	*5*	*21.7*	36	*21.4*	87	
	Unknown	4	*2.3*	*0*	*0.0*	4	*2.4*	8	*0.23*
Alive at censor date	**Yes**	144	*83.2*	*13*	*56.5*	122	*72.6*	269	
	No	29	*16.8*	*10*	*43.5*	56	*33.3*	95	*<0.01*
Treatment received	**Surgery**	88	*50.9*	*0*	*0.0*	48	*28.6*	136	
	Surgery & additonal therapy	49	*28.3*	*13*	*56.5*	73	*43.5*	135	
	Chemoradiotherapy	25	*14.5*	*8*	*34.8*	39	*23.2*	72	
	None	11	*6.4*	*2*	*8.7*	8	*4.8*	21	*<0.01*
Total (number of patients)		173		23		168		364	

Table 81: STS patient details by type of specialist inpatient care

		Limited		STS		TCT		STS & TCT			
		n	%	n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	74	*42.8*	*46*	*52.9*	21	*63.6*	*21*	*29.6*	162	
	20-24	99	*57.2*	*41*	*47.1*	12	*36.4*	*50*	*70.4*	202	*0.02*
Gender	**Male**	88	*50.9*	*51*	*58.6*	19	*57.6*	*38*	*53.5*	196	
	Female	85	*49.1*	*36*	*41.4*	14	*42.4*	*33*	*46.5*	168	*0.66*
Diagnostic group	**Fibrosarcoma**	45	*26.0*	*11*	*12.6*	1	*3.0*	*11*	*15.5*	68	
	Rhabdomyosarcoma	19	*11.0*	*30*	*34.5*	12	*36.4*	*20*	*28.2*	81	
	Other specified STS	81	*46.8*	*35*	*40.2*	10	*30.3*	*27*	*38.0*	153	
	Unspecified	28	*16.2*	*11*	*12.6*	10	*30.3*	*13*	*18.3*	62	*<0.01*
Deprivation	**Most affluent**	23	*13.3*	*16*	*18.4*	2	*6.1*	*9*	*12.7*	50	
	4	35	*20.2*	*16*	*18.4*	3	*9.1*	*14*	*19.7*	68	
	3	32	*18.5*	*16*	*18.4*	10	*30.3*	*16*	*22.5*	74	
	2	33	*19.1*	*24*	*27.6*	9	*27.3*	*11*	*15.5*	77	
	Most deprived	46	*26.6*	*14*	*16.1*	9	*27.3*	*18*	*25.4*	87	
	Unknown	4	*2.3*	*1*	*1.1*	0	*0.0*	*3*	*4.2*	8	*0.34*
Alive at censor date	**Yes**	144	*83.2*	*63*	*72.4*	16	*48.5*	*46*	*64.8*	269	
	No	29	*16.8*	*24*	*27.6*	17	*51.5*	*25*	*35.2*	95	*<0.01*
Treatment received	**Surgery**	88	*50.9*	*29*	*33.3*	0	*0.0*	*19*	*26.8*	136	
	Surgery & additonal therapy	49	*28.3*	*36*	*41.4*	22	*66.7*	*28*	*39.4*	135	
	Chemoradiotherapy	25	*14.5*	*16*	*18.4*	9	*27.3*	*22*	*31.0*	72	
	None	11	*6.4*	*6*	*6.9*	2	*6.1*	*2*	*2.8*	21	*<0.01*
Total (number of patients)		173		87		33		71		364	

10.4 Patient outcomes

10.4.1 Treatment received

The majority of patients diagnosed with a soft tissue sarcoma underwent surgery, either with or without additional therapy (Figure 67). No patient who had had some specialist care underwent surgery alone. This group also had the largest proportion of patients receiving chemoradiotherapy without surgery. Very few patients were recorded as having no treatment (>10%). This proportion was the smallest in patients who had mostly specialist care. When treatment was examined by the type of specialist care received from time of diagnosis to first admission, surgery, chemotherapy and radiotherapy varied very little by either the amount or type of specialist care received (Table 82 & Table 83).

Figure 67: Treatment received, by amount of specialist care

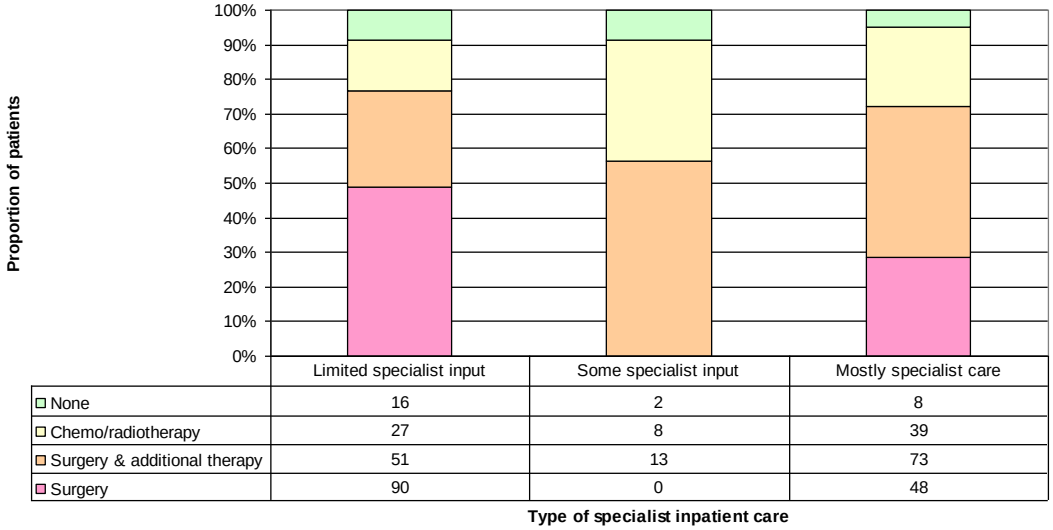


Figure 68: Treatment received, by type of specialist care

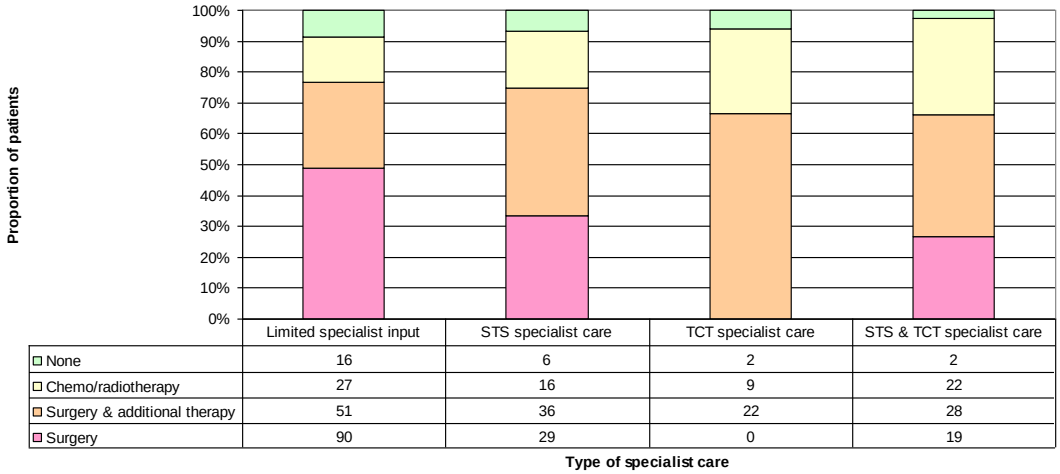


Table 82: Time from diagnosis to first admission and first treatment, by amount of specialist input (a negative value represents an episode prior to diagnosis)

	Weeks from diagnosis to first admission		Weeks from diagnosis to first chemotherapy		Weeks from diagnosis to first radiotherapy		Weeks from diagnosis to first surgery	
	Median	Range	Median	Range	Median	Range	Median	Range
Limited specialist input	0	-4 - 32	4	-1 - 57	20	20 - 20	3	-1 - 232
Some specialist input	0	-4 - 5	3	0 - 53	47	47 - 47	3	0 - 29
Mostly specialist care	0	-4 - 23	4	-4 - 70	14	3 - 39	5	0 - 82

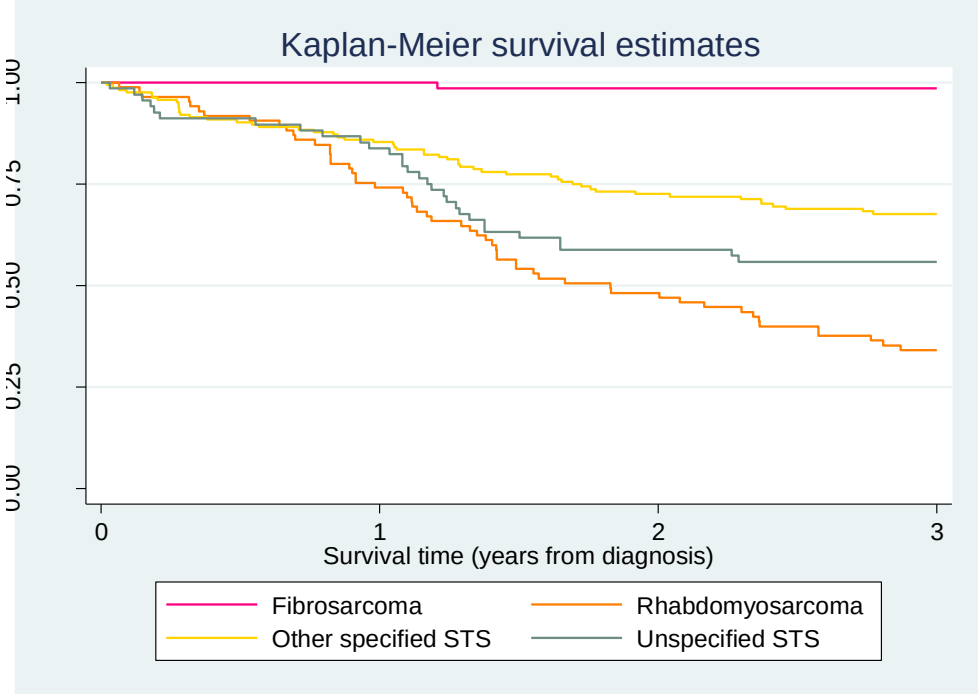
Table 83: Time from diagnosis to first admission and first treatment, by type of specialist input (a negative value represents an episode prior to diagnosis)

	Weeks from diagnosis to		Weeks from diagnosis to		Weeks from diagnosis to		Weeks from diagnosis to	
	Median	Range	Median	Range	Median	Range	Median	Range
Limited specialist input	0	-4 - 32	4	-1 - 57	20	20 - 20	3	-1 - 232
STS	0	-4 - 23	3	-1 - 69		-	4.5	0 - 82
TCT	0	-4 - 22	4.5	-4 - 27	21.5	4 - 39	4.5	0 - 25
STS & TCT	0	-4 - 18	4.5	-1 - 70	14	3 - 47	8	0 - 32

10.4.2 Survival

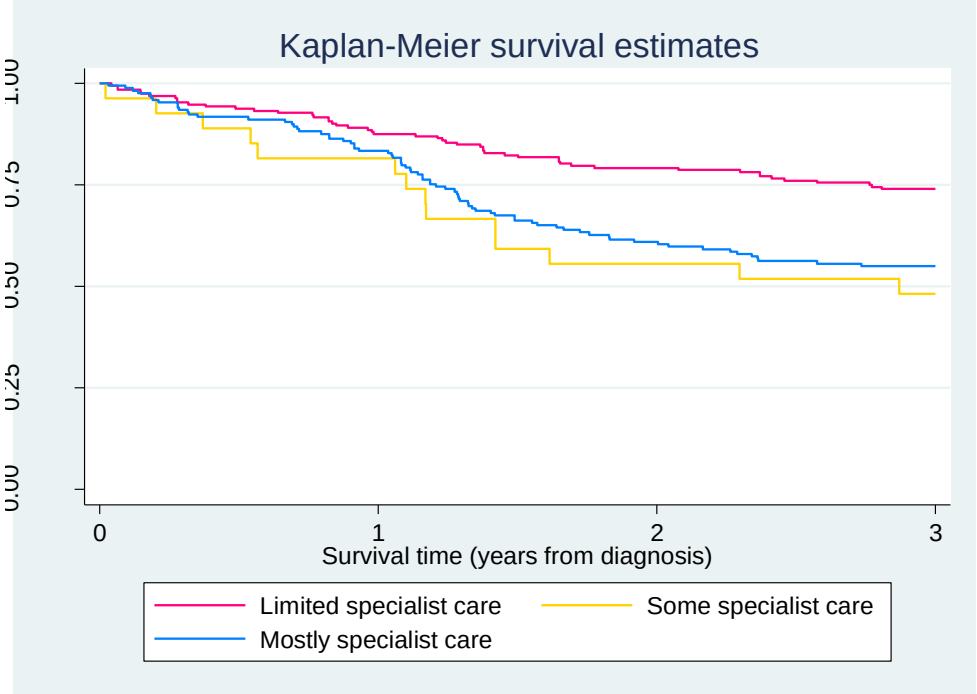
Survival varied by diagnostic subtype for patients with a soft tissue sarcoma. Close to 100% of patients diagnosed with a fibrosarcoma were alive three years post diagnosis. In contrast less than 35% of those with a rhabdomyosarcoma were alive at the same point. Survival from other and unspecified STS was in between these two extremes (Figure 69).

Figure 69: Survival to three years from diagnosis, by diagnostic subtype of STS



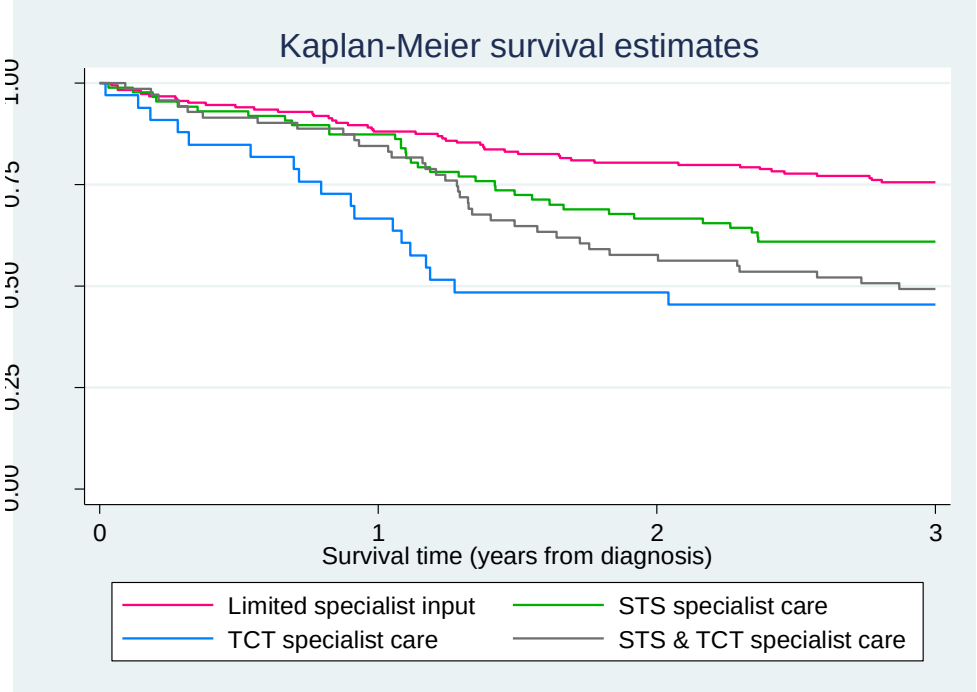
Those with limited specialist input had the best survival to three years with approximately 75% of patients alive at this point. Less than 50% of those with some specialist care were alive at the same point (Figure 70).

Figure 70: Survival to three years by amount to specialist care received, STS patients



Survival also varied by the type of specialist care received, those with limited specialist input fared the best with 75% surviving to three years. TCT specialist care without the involvement of an STS centre was associated with the poorest survival (under 50% surviving to three years). Patients admitted to an STS centre, with or without TCT involvement were seen between these two extremes of survival (Figure 71).

Figure 71: Survival to three years from diagnosis by type of specialist inpatient care, STS tumours



The global results of the proportional hazards test showed no statistical significance and therefore the model was applied (Table 84). Age was assessed both categorically and continuously, there was no evidence to support that the inclusion of a non-linear term for age produced a better fitting model (p=0.72) and so a continuous scale was used.

Table 84: Results of the proportional hazards test (stphtest)

		rho	χ2	Prob> χ2
Age at diagnosis		-0.06	0.43	*0.51*
Gender	**Male**	1.00		
	Female	-0.12	2.18	*0.14*
Year of diagnosis		0.07	0.69	*0.41*
Deprivation	**1 (Most deprived)**	1.00		
	2	-0.09	1.02	*0.31*
	3	0.01	0.03	*0.87*
	4	0.10	1.27	*0.26*
	5 (Most affluent)	0.14	2.47	*0.12*
Diagnostic subgroup	**Other STS**	1.00		
	Fibrosarcoma	0.01	0.01	*0.93*
	Rhabdomyosarcoma	0.18	4.79	*0.03*
	Unspecified STS	0.01	0.03	*0.87*
Amount of specialist care	**Limited**	1.00		
	Some	0.04	0.28	*0.59*
	Mostly	0.07	0.62	*0.43*
Type of specialist care	**Limited**	1.00		
	STS	-0.11	1.53	*0.22*
	TCT	-0.17	4.28	*0.04*
	STS & TCT			
Global test			23.28	*0.06*

The Cox regression model (Table 85) demonstrated that increasing age at diagnosis was associated with an 8% increased risk of death (HR 1.08 95%CI 1.01-1.16). A diagnosis of rhabdomyosarcoma compared to other STS tumours was associated with a two-fold increased risk of death (HR 2.35 95%CI 1.51-3.64). Female gender and a diagnosis of fibrosarcoma were both factors linked to a statistically significant decrease in risk of death of 44% and 96% (HR 0.56 95%CI 0.37-0.83 and HR 0.04 95%CI 0.01-0.28) respectively. Receiving some or mostly specialist care was associated with an increased risk of death compared to limited specialist care, as was receiving TCT care alone, although all were non-significant. Receiving limited specialist input and STS and TCT input was shown to have the same associated risk.

Table 85: Cox regression model for soft tissue sarcoma

				Confidence intervals	
		Haz. Ratio	*p value*	Lower 95%	Upper 95%
Age at diagnosis		1.08	*0.03*	1.01	1.16
Gender	**Male**	1.00			
	Female	0.56	*<0.01*	0.37	0.83
Year of diagnosis		1.05	*0.38*	0.94	1.17
Deprivation	**Most deprived**	1.00			
	2	0.80	*0.44*	0.46	1.40
	3	0.75	*0.30*	0.44	1.29
	4	1.19	*0.52*	0.69	2.06
	Most affluent	0.89	*0.69*	0.49	1.59
Diagnostic subgroup	**Other STS**	1.00			
	Fibrosarcoma	0.04	*<0.01*	0.01	0.28
	Rhabdomyosarcoma	2.35	*<0.01*	1.51	3.64
	Unspecified STS	1.32	*0.29*	0.80	2.17
Amount of specialist care	**Limited**	1.00			
	Some	2.00	*0.07*	0.95	4.17
	Mostly	1.59	*0.06*	0.98	2.58
Type of specialist care	**Limited**	1.00			
	STS	0.80	*0.37*	0.49	1.31
	TCT	1.19	*0.58*	0.64	2.21
	STS & TCT	1.00			

10.4.3 Health service usage

The peak in admissions during treatment was seen at the same time point for all amounts of specialist care groups (Figure 72). The same was seen when the data were examined according to type of specialist input (Figure 73).

Figure 72: Number of admissions per week, by time from diagnosis and amount of specialist care

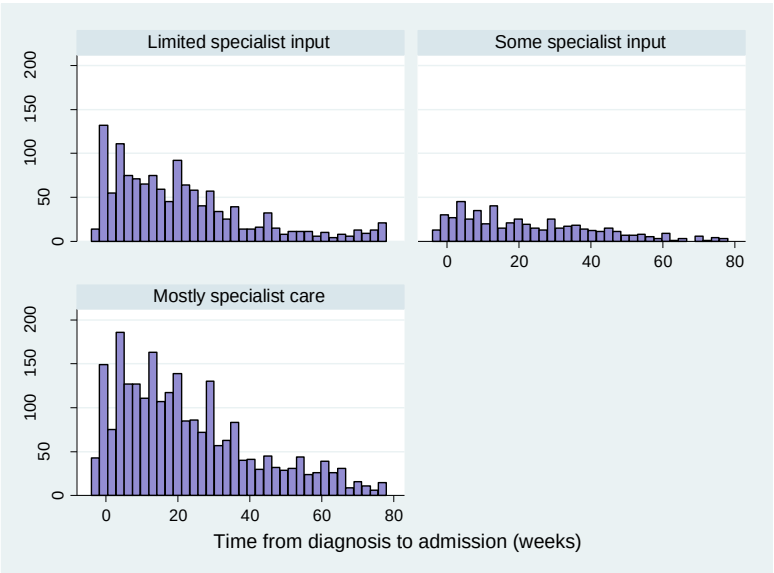
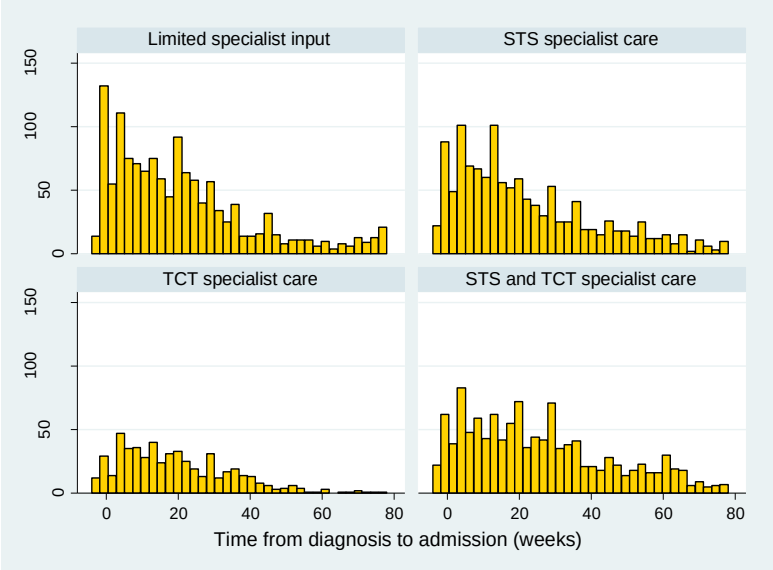


Figure 73: Number of admissions per week, by time from diagnosis and type of specialist care



The graphs examining the data by the amount of specialist care received show a very similar pattern; patients with some specialist input had the greatest number of admissions during treatment (Figure 74), had the largest proportion of unplanned admissions (Figure 75) and spent the largest part of the treatment period as an inpatient (Figure 76). Patients with limited specialist input had the lowest score for each of these aforementioned variables.

Patients with TCT specialist care had the greatest number of admissions during treatment (Figure 67), had the largest proportion of unplanned admissions (Figure 68) and spent the largest part of the treatment period as an inpatient (Figure 69) when compared to all other types of specialist care.

Figure 74: Median number of admissions per patient during treatment

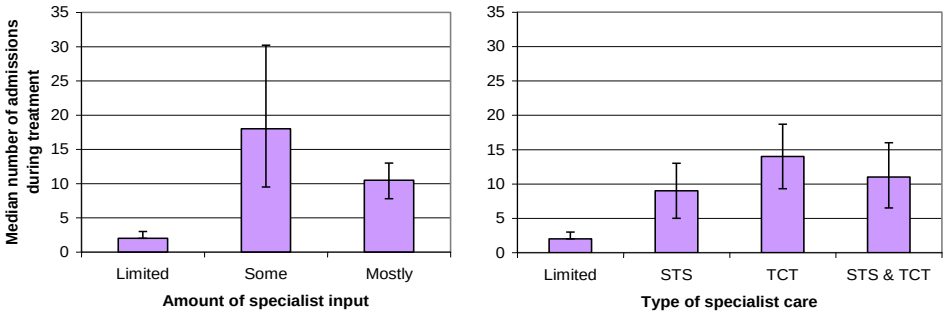


Figure 75: Median proportion of admissions, per patient, during treatment which were unplanned

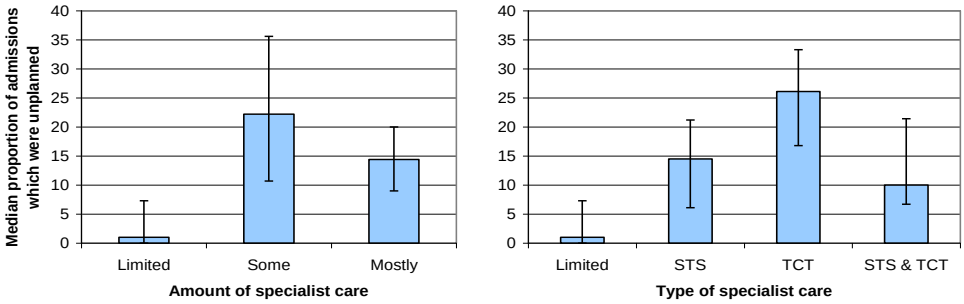
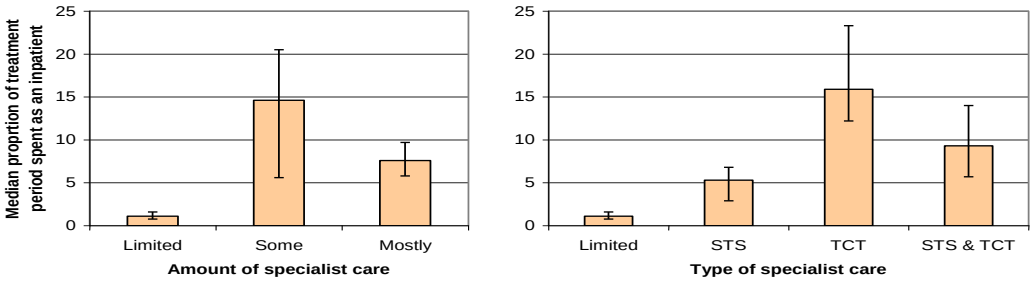


Figure 76: Median proportion of the treatment period spent as an inpatient, per patient



10.4.4 Health service costs

The total costs of admissions during treatment (Figure 77) are reflective of the fact that some groups had higher levels of admission than others. The cost per admission (Figure 78) mirrors the results seen when examining the total cost.

Figure 77: Median total cost of admissions during treatment, per patient

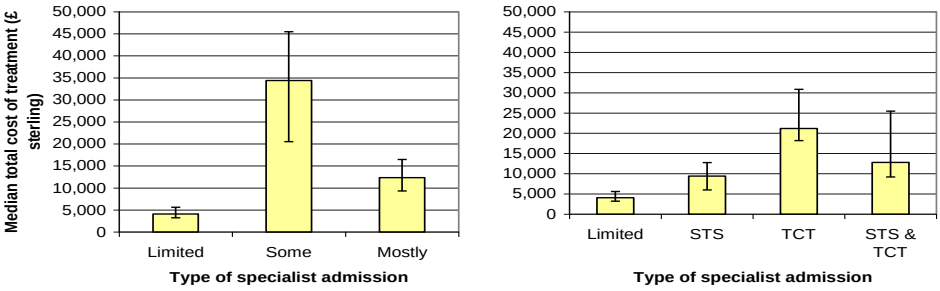
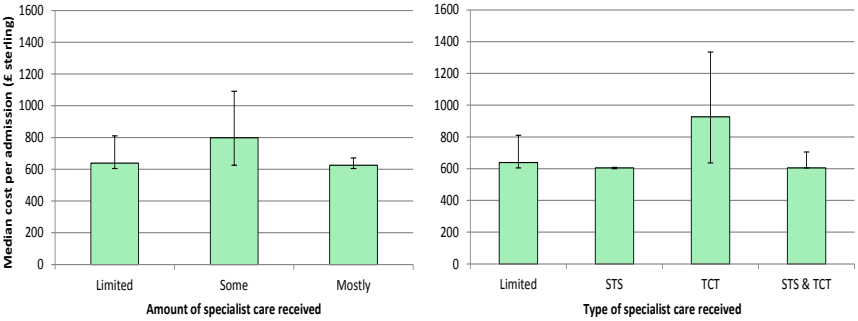


Figure 78: Median cost per admission

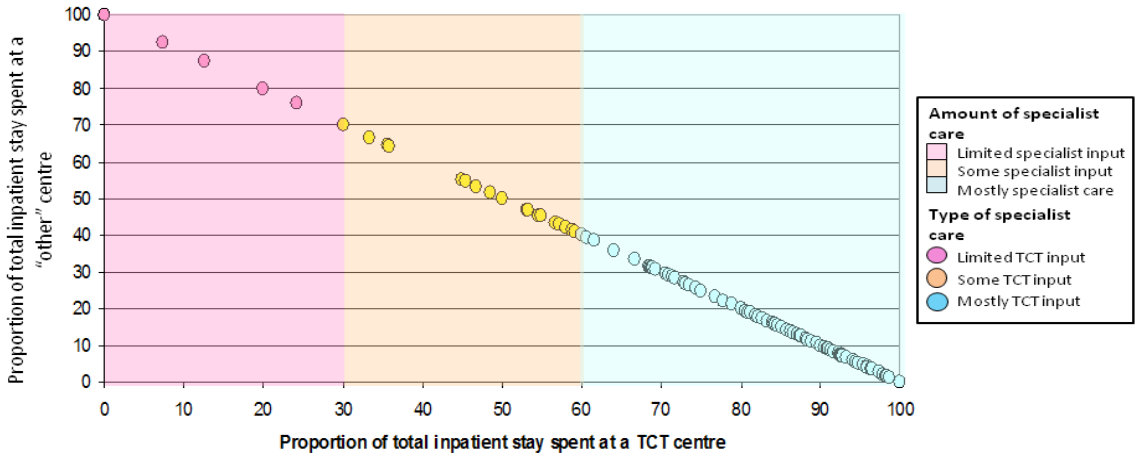


Chapter 11 Germ cell and trophoblastic neoplasms

11.1 Specialist care

As there were no site-specific centres for the treatment of germ cell tumour at the time of this study the proportion of total inpatient time during treatment spent at a TCT centre was compared to the time spent at any other type of hospital for germ cell patients.

Figure 79: Assignment of germ cell patients to a "level" of specialist care using the proportion of inpatient time spent in a specialist centre



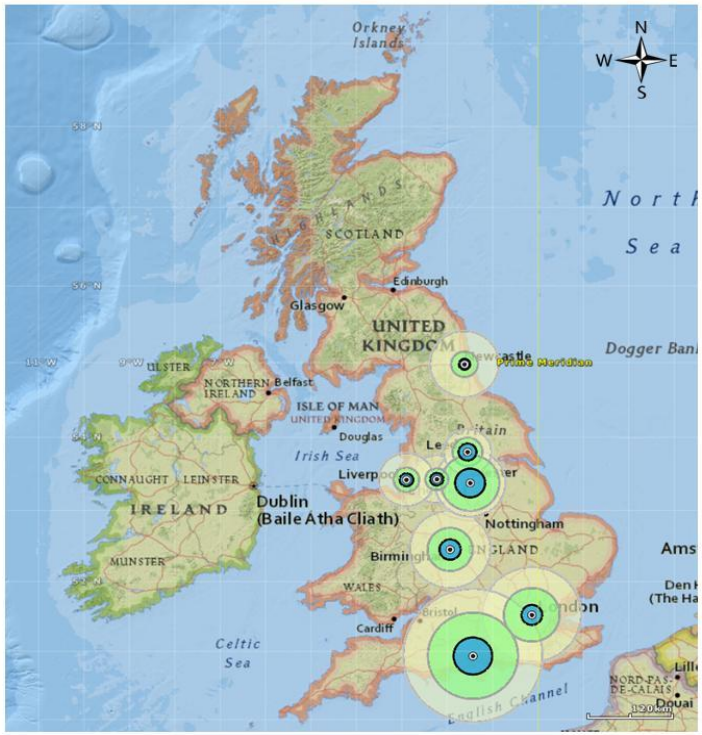
11.2 Access to specialist care

11.2.1 Hospital catchment areas

With the exception of the Christie, all TCT units showed a smaller actual catchment area (Map 18) than theoretical one (Map 19). Leeds and Newcastle had the smallest proportion of patients, for whom they were the closest centre who were not admitted to a TCT centre during their treatment (Table 86). In contrast 90% (338 out of 374 patients) who lived the closest to UCL were not admitted to a TCT centre during treatment. Southampton and Alder Hey had similarly high numbers.

Very few patients were admitted to a centre other than their closest one. With the exception of the Christie, who admitted 22 patients for whom Alder Hey was the closest unit (Table 86).

Map 19: Site of TCT centres in England (2001-2009) and the residential location of germ cell tumour patients closest to each



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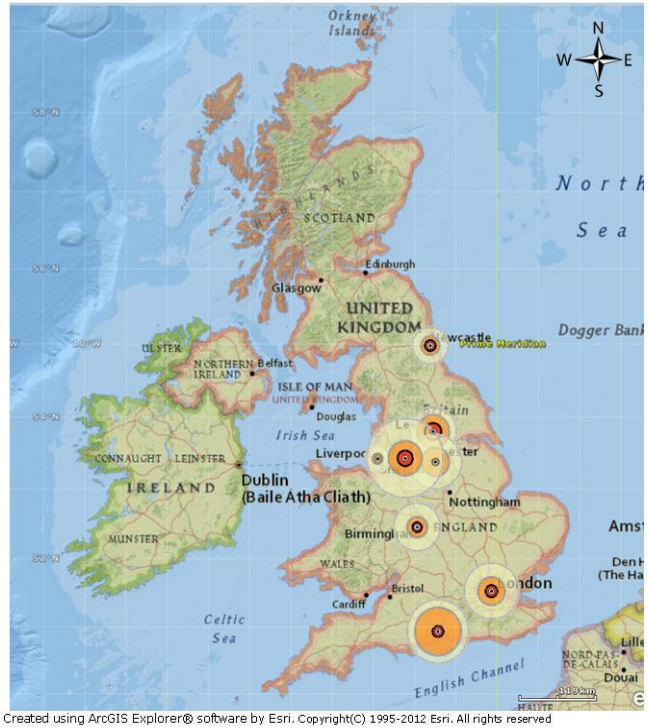
Key

Location of TCT centres

Proportion of germ cell tumour patients

25% of cases *50% of cases* *75% of cases*

Map 18: Site of TCT centres in England (2001-2009) and the residential location of germ cell tumour patients admitted to each



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Key

Location of TCT centres

Proportion of germ cell patients

25% of cases *50% of cases* *75% of cases*

Table 86: Numbers of germ cell tumour patients closest to each TCT centre, and the centre actually attended

		NHS trust with a TCT unit to which the patient was admitted																		
		Alder Hey Children's NHS Foundation Trust		Leeds Teaching Hospitals NHS Trust		Sheffield Teaching Hospitals NHS Foundation Trust		University Hospital Southampton NHS Foundation Trust		The Christie NHS Foundation Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		University College London Hospitals NHS Foundation Trust		University Hospitals Birmingham NHS Foundation Trust		None		Total
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Closest NHS trust with a TCT unit at the time of admission	Alder Hey Children's NHS Foundation Trust	**3**	*3.3*	**0**	*0*	**1**	*1.1*	**0**	*0*	**22**	*24*	**2**	*2.2*	**0**	*2.4*	**1**	*1.1*	**62**	*68*	**91**
	Leeds Teaching Hospitals NHS Trust	**0**	*0*	**77**	*69*	**2**	*1.8*	**1**	*0.9*	**1**	*0.9*	**0**	*0*	**1**	*0*	**0**	*0*	**29**	*26*	**111**
	Sheffield Teaching Hospitals NHS Foundation Trust	**0**	*0*	**1**	*1*	**31**	*32*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*1*	**63**	*66*	**96**
	University Hospital Southampton NHS Foundation Trust	**1**	*0.5*	**0**	*0*	**0**	*0*	**46**	*24*	**1**	*0.5*	**0**	*0*	**0**	*0*	**4**	*2.1*	**142**	*73*	**194**
	The Christie NHS Foundation Trust	**0**	*0*	**1**	*1*	**1**	*1*	**0**	*0*	**41**	*43*	**0**	*0*	**0**	*0*	**3**	*3.1*	**50**	*52*	**96**
	The Newcastle upon Tyne Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**1**	*1.5*	**0**	*0*	**0**	*0*	**43**	*65*	**0**	*99*	**0**	*0*	**22**	*33*	**66**
	University College London Hospitals NHS Foundation Trust	**0**	*0*	**1**	*0.3*	**0**	*0*	**5**	*1.3*	**0**	*0*	**1**	*0.3*	**28**	*12*	**1**	*0.3*	**338**	*90*	**374**
	University Hospitals Birmingham NHS Foundation Trust	**0**	*0*	**0**	*0*	**1**	*0.6*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**61**	*34*	**116**	*65*	**178**
	Total	**4**		**80**		**37**		**52**		**65**		**46**		**29**		**71**		**822**		**1206**

Increasing travel distance from home to a TCT centre decreased the odds of a TCT admission during treatment by 15% for each 5km increase in distance between home and the closest centre(OR 0.85 95%CI 0.82-0.88)(Table 87). A diagnosis of a non-gonadal germ cell tumour significantly increased the likelihood of a TCT admission (OR 2.52 95%CI 1.54-4.14).

Table 87: Likelihood of admission to a TCT centre for germ cell tumour patients

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	0.90	0.68	0.56	1.47
Age at diagnosis		0.95	0.07	0.89	1.01
Diagnostic group	Gonadal germ cell & trophoblastic neoplasm	1.00			
	Non-gonadal germ cell & trophoblastic neoplasm	2.52	<0.01	1.54	4.14
Deprivation	Most deprived	1.00			
	2	0.68	0.09	0.43	1.06
	3	0.88	0.56	0.56	1.36
	4	0.53	0.01	0.33	0.85
	Most affluent	0.65	0.06	0.42	1.01
Distance to nearest TCT centres (increase of 5km)		0.85	<0.01	0.82	0.88

11.2.2 Geographical distribution of patients

In four of the 31 cancer networks the majority of patients received mostly specialist TCT inpatient care (Table 88). All four networks either had a TCT centre in place during the study period or had pathways in place for patient transfer. The majority of patients received limited specialist input, several of the networks where this was the case had TCT centres at the time.

Table 88: Cancer network of residence at diagnosis and level of specialist inpatient care, germ cell tumours (highlighted sections represent the highest proportion of patients for each cancer network)

	Neither		Some TCT		Mostly TCT		Number of patients
	n	%	n	%	n	%	
Lancashire & South Cumbria	30	65.2	1	2.2	15	32.6	46
Greater Manchester & Cheshire	34	45.3	5	6.7	36	48.0	75
Merseyside & Cheshire	49	90.7	1	1.9	4	7.4	54
Yorkshire	22	24.4	4	4.4	64	71.1	90
Humber & Yorskhire Coast	22	84.6	1	3.8	3	11.5	26
North Trent	18	41.9	1	2.3	24	55.8	43
Pan Birmingham	5	10.6	4	8.5	38	80.9	47
Arden	20	83.3	0	0.0	4	16.7	24
Mid Trent	38	97.4	0	0.0	1	2.6	39
Derby/ Burton	14	87.5	1	6.3	1	6.3	16
Leicestershire, Northants & Rutland	35	100.0	0	0.0	0	0.0	35
Mount Vernon	23	92.0	0	0.0	2	8.0	25
West London	23	100.0	0	0.0	0	0.0	23
North London	18	58.1	0	0.0	13	41.9	31
North East London	24	96.0	1	4.0	0	0.0	25
South East London	19	86.4	0	0.0	3	13.6	22
South West London	26	96.3	1	3.7	0	0.0	27
Peninsula	31	96.9	1	3.1	0	0.0	32
Dorset	14	100.0	0	0.0	0	0.0	14
Avon, Somerest & Wiltshire	48	100.0	0	0.0	0	0.0	48
3 Counties	27	96.4	0	0.0	1	3.6	28
Thames Valley	58	95.1	0	0.0	3	4.9	61
Central South Coast	61	100.0	0	0.0	0	0.0	61
Surrey, West Sussex & Hampshire	31	100.0	0	0.0	0	0.0	31
Sussex	26	100.0	0	0.0	0	0.0	26
Kent & Medway	39	97.5	0	0.0	1	2.5	40
Greater Midlands	33	70.2	0	0.0	14	29.8	47
North of England	69	98.6	1	1.4	0	0.0	70
Anglia	65	98.5	0	0.0	1	1.5	66
Essex	27	93.1	1	3.4	1	3.4	29
Wales	2	100.0	0	0.0	0	0.0	2
Unknown	2	66.7	0	0.0	1	33.3	3
Total	953	79.0	23	1.9	230	19.1	1,206

11.2.3 High volume centres

Of the eight trusts with a TCT unit during the study period, seven were seen in the top 15 in terms of both patient numbers (Table 89) and admissions to hospital (Table 90). These seven trusts admit 30.1% of all germ cell patients and account for 32.8% of all admissions during treatment for germ cell tumour patients. The remaining trusts seen in the top 15 are all large teaching hospital trusts or cancer centres, treating large volumes of patients annually.

Table 89: Number of germ cell tumour patients admitted to each NHS trust during the treatment period (top 15 only)

		Number of patients	
Rank	NHS Trust	n	%
1	Leeds Teaching Hospitals NHS Trust	75	*6.2*
2	University Hospitals Birmingham NHS Foundation Trust	68	*5.6*
3	The Christie NHS Foundation Trust	62	*5.1*
4	University Hospitals Southampton NHS Trust	49	*4.1*
5	The Newcastle upon Tyne Hospitals NHS Foundation Trust	45	*3.7*
5	University Hospitals Bristol NHS Foundation Trust	45	*3.7*
7	The Royal Marsden NHS Foundation Trust	41	*3.4*
8	Nottingham University Hospitals NHS Trust	39	*3.2*
9	Sheffield Teaching Hospitals NHS Foundation Trust	37	*3.1*
10	Clatterbridge Centre for Oncology NHS Trust	31	*2.6*
10	Imperial College Healthcare NHS Trust	31	*2.6*
10	Oxford Radcliffe Hospitals NHS Trust	31	*2.6*
13	University College London Hospitals NHS Trust	28	*2.3*
14	Cambridge University Hospitals NHS Foundation Trust	27	*2.2*
15	Lancashire Teaching Hospitals NHS Foundation Trust	25	*2.1*
	Total number of patients	1,206	

TCT centre

Table 90: Number of admissions to each NHS trust during the treatment period, germ cell tumour patients

Rank	NHS Trust	Number of admissions n	%
1	The Christie NHS Foundation Trust	629	*8.1*
2	Leeds Teaching Hospitals NHS Trust	536	*6.9*
3	Sheffield Teaching Hospitals NHS Foundation Trust	368	*4.8*
4	The Newcastle upon Tyne Hospitals NHS Foundation Trust	338	*4.4*
5	The Royal Marsden NHS Foundation Trust	303	*3.9*
6	University Hospitals Birmingham NHS Foundation Trust	278	*3.6*
7	Nottingham University Hospitals NHS Trust	224	*2.9*
8	University Hospitals Bristol NHS Foundation Trust	209	*2.7*
9	University Hospitals Southampton NHS Trust	200	*2.6*
10	Imperial College Healthcare NHS Trust	196	*2.5*
11	Lancashire Teaching Hospitals NHS Foundation Trust	189	*2.4*
12	Cambridge University Hospitals NHS Foundation Trust	185	*2.4*
13	University College London Hospitals NHS Trust	185	*2.4*
14	Oxford Radcliffe Hospitals NHS Trust	177	*2.3*
15	Northampton General Hospital NHS Trust	164	*2.1*
	Total number of admissions	7,729	

TCT centre

11.3 Variation in the uptake of specialist care

The majority of patients diagnosed with a germ cell tumour were in the older age group (aged 20 to 24 at diagnosis). This was the same across the three specialist care groups, however the ratio of older to younger patients was lower in the patients who received some specialist input (Table 91). Patients were predominantly male, but again the ratio of male to female was lower in the group of patients receiving some specialist input. The same was seen when examining diagnostic groups, with the majority of patients having been diagnosed with a gonadal germ cell tumour. The proportion of patients surviving to the end of treatment was high for all specialist care groups (98.8% to 89.6%). This was highest in patients with limited specialist input and lowest in those who had mostly specialist care.

Table 91: Germ cell tumour patient details by amount of specialist inpatient care

		Limited		Some TCT		Mostly TCT			
		n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	249	*26.1*	11	*47.8*	*75*	*32.6*	335	
	20-24	704	*73.9*	12	*52.2*	*155*	*67.4*	871	*0.01*
Gender	**Male**	869	*91.2*	18	*78.3*	*205*	*89.1*	1,092	
	Female	84	*8.8*	5	*21.7*	*25*	*10.9*	114	*0.16*
Diagnostic group	**Gonadal germ cell & trophoblastic neoplasms**	894	*93.8*	17	*73.9*	*203*	*88.3*	1,114	
	Germ cell & trophoblastic neoplasms of non-gonadal sites	59	*6.2*	6	*26.1*	*27*	*11.7*	92	*<0.01*
Deprivation	**Most affluent**	207	*21.7*	3	*13.0*	*44*	*19.1*	254	
	4	200	*21.0*	2	*8.7*	*32*	*13.9*	234	
	3	170	*17.8*	6	*26.1*	*46*	*20.0*	222	
	2	204	*21.4*	2	*8.7*	*41*	*17.8*	247	
	Most deprived	168	*17.6*	10	*43.5*	*66*	*28.7*	244	
	Unknown	4	*0.4*	0	*0.0*	*1*	*0.4*	5	*<0.01*
Alive at censor date	**Yes**	942	*98.8*	22	*95.7*	*206*	*89.6*	1,170	
	No	11	*1.2*	1	*4.3*	*24*	*10.4*	36	*<0.01*
Treatment received	**Surgery**	311	*32.6*	0	*0.0*	*10*	*4.3*	321	
	Surgery & additonal therapy	598	*62.7*	19	*82.6*	*191*	*83.0*	808	
	Chemoradiotherapy	31	*3.3*	3	*13.0*	*27*	*11.7*	61	
	None	15	*1.6*	1	*4.3*	*2*	*0.9*	18	*<0.01*
Total (number of patients)		953		23		230		1,206	

11.4 Patient outcomes

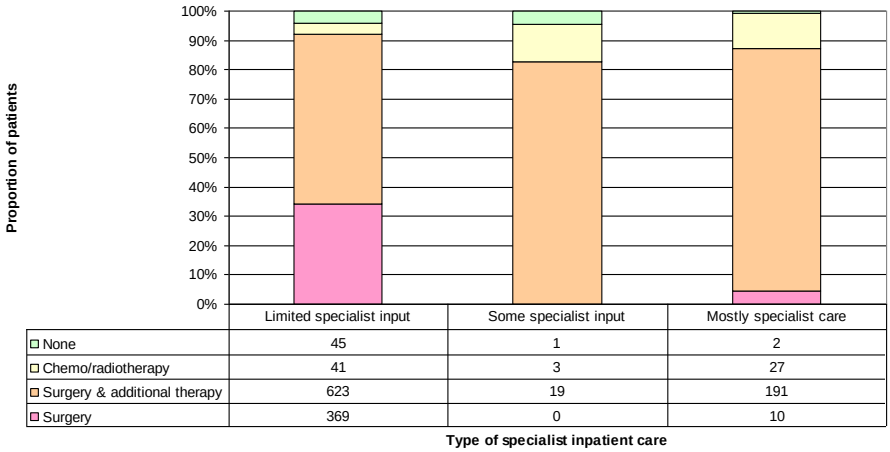
11.4.1 Treatment received

The majority of patients diagnosed with a germ cell tumour were treated with a major surgical resection combined with additional therapy (Figure 80). This was seen across all the specialist

care groups, with the vast majority undergoing chemoradiotherapy additional to their surgical resection. No patients who had received some specialist input underwent surgery alone; however this was seen in the other two specialist care groups. Very few patients were recorded as having had no treatment but this proportion was largest in those with some specialist input.

The time from diagnosis to surgery, first admission and first chemotherapy varied very little between groups (Table 92).

Figure 80: Treatment received, by specialist group



	Limited specialist input	Some specialist input	Mostly specialist care
None	45	1	2
Chemo/radiotherapy	41	3	27
Surgery & additional therapy	623	19	191
Surgery	369	0	10

Table 92: Time from diagnosis to first admission and first treatment, by specialist group (a negative value represents an episode prior to diagnosis)

	Weeks from diagnosis to first admission		Weeks from diagnosis to first chemotherapy		Weeks from diagnosis to first surgery	
	Median	Range	Median	Range	Median	Range
Limited specialist input	0	-4 - 51	6	-4 - 53	0	-4 - 139
Some specialist input	0	-3 - 0	5	0 - 18	0	0 - 0
Mostly specialist care	0	-4 - 9	5	-4 - 51	0	-4 - 39

11.4.2 Survival

Survival from germ cell and trophoblastic neoplasms was over 75% at three years for this group. Those diagnosed with non-gonadal tumours fared worse than those with gonadal tumours (Figure 81). Limited specialist input was associated with the best survival, those with mostly specialist care had the worst survival of the three specialist care groups (Figure 82).

Figure 81: Survival to three years from diagnosis, by diagnostic subtype of germ cell tumour

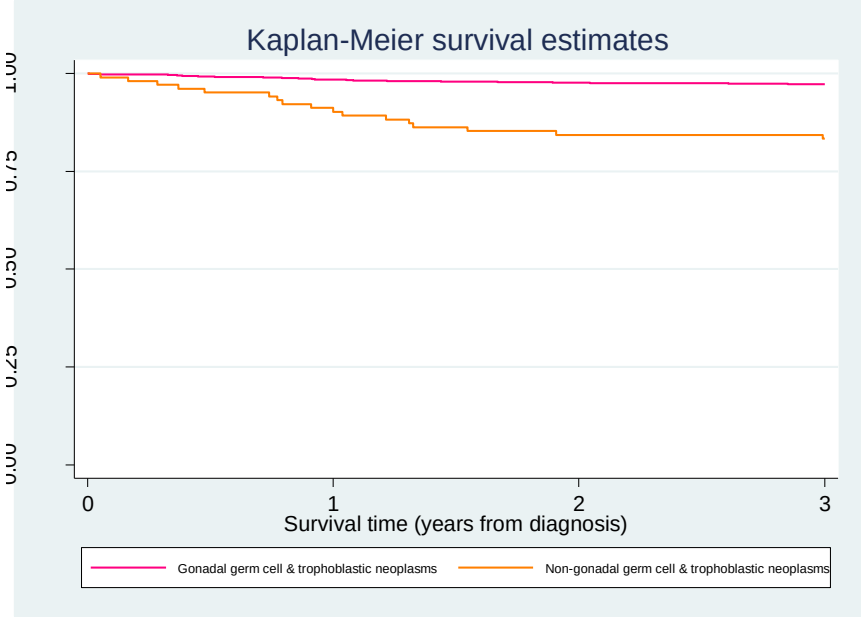
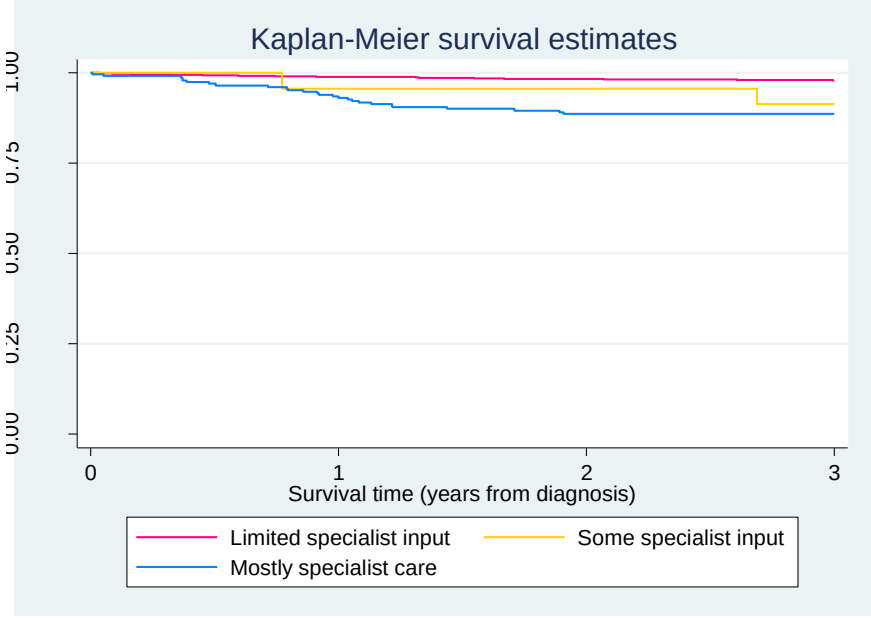


Figure 82: Survival to three years by amount to specialist care received, germ cell tumour patients



The global proportional hazards test was non-significant showing that overall the proportional hazards assumption held (Table 93), however, deprivation quintile was shown to be an area of concern. A likelihood ratio test demonstrated no benefit when including age as a categorical variable as opposed to a continuous one and so the latter was chosen (p=0.06).

Table 93: Results of the proportional hazards test (stphtest)

		rho	χ2	Prob> χ2
Age at diagnosis		0.12	0.88	0.35
Gender	**Male**	1.00		
	Female	0.09	0.41	0.52
Year of diagnosis		-0.07	0.31	0.58
Deprivation	**1 (Most deprived)**	1.00		
	2	0.01	0.01	0.92
	3	-0.03	0.03	0.86
	4	0.29	4.18	0.04
	5 (Most affluent)	-0.01	0.01	0.93
Diagnostic subgroup	**Gonadal germ cell neoplasms**	1.00		
	Non-gonadal germ cell neoplasms	-0.01	0.01	0.94
Amount of specialist care	**Limited**	1.00		
	Some	0.20	2.05	0.15
	Mostly	-0.08	0.30	0.58
Global test			11.72	0.30

Only diagnostic subgroup and amount of specialist care received were shown to have a statistically significant effect on survival (Table 94). Patients diagnosed with a non-gonadal tumour had a five-fold increased risk of death (HR 5.25 95%CI 2.81-9.81) while those receiving mostly specialist care had a similar 4.8 times increased risk of death (HR 4.83 95%CI 2.70-8.64). Receiving some specialist care also increased the risk but this was not statistically significant.

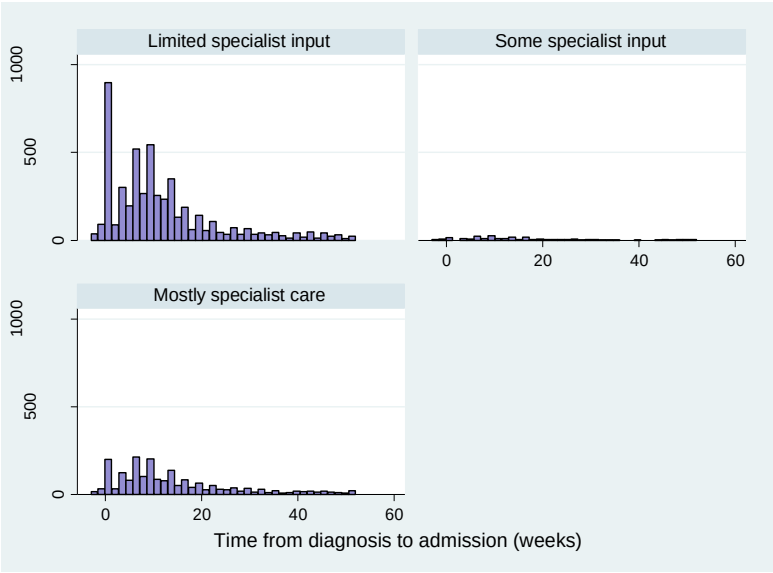
Table 94: Cox regression model for germ cell and trophoblastic neoplasms

				Confidence intervals	
		Haz. Ratio	*p value*	Lower 95%	Upper 95%
Age at diagnosis		1.02	*0.76*	0.91	1.14
Gender	**Male**	1.00			
	Female	0.69	*0.48*	0.24	1.93
Year of diagnosis		1.05	*0.56*	0.89	1.25
Deprivation	**Most deprived**	1.00			
	2	0.90	*0.82*	0.36	2.26
	3	1.09	*0.85*	0.45	2.59
	4	1.41	*0.41*	0.62	3.23
	Most affluent	0.99	*0.98*	0.40	2.44
Diagnostic subgroup	**Gonadal germ cell neoplasms**	1.00			
	Non-gonadal germ cell neoplasms	5.25	*<0.01*	2.81	9.81
Amount of specialist care	**Limited**	1.00			
	Some	2.92	*0.16*	0.65	12.99
	Mostly	4.83	*<0.01*	2.70	8.64

11.4.3 Health service usage

The peak of admissions was seen at the same point for all specialist care groups (Figure 83) however the peak in admissions during the week containing diagnosis was greater in patients with limited specialist input than seen in any other group.

Figure 83: Number of admissions per week, by time from diagnosis and specialist group



Patients with some specialist care had the highest number of admissions during treatment (Figure 84), had the largest number of unplanned admissions (Figure 85) and spent the largest amount of the treatment period as an inpatient (Figure 86).

Figure 84: Median number of admissions per patient during treatment, by specialist group

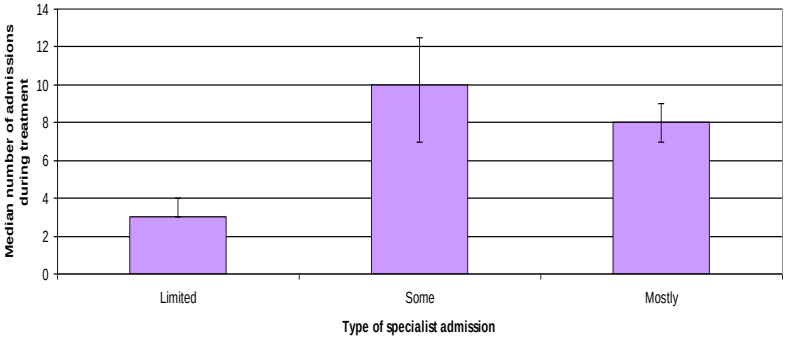


Figure 85: Median proportion of admissions, per patient, during treatment which were unplanned

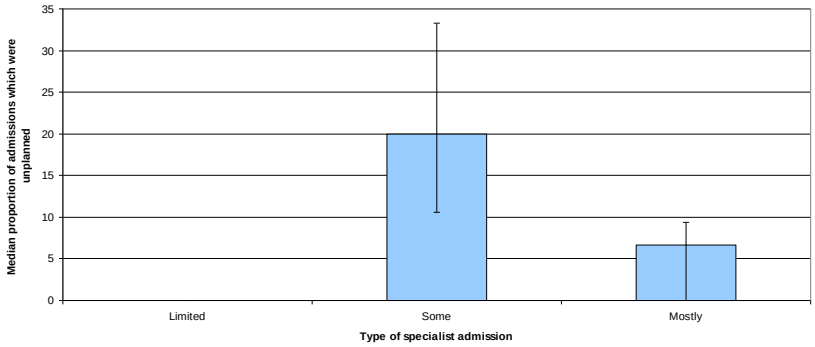
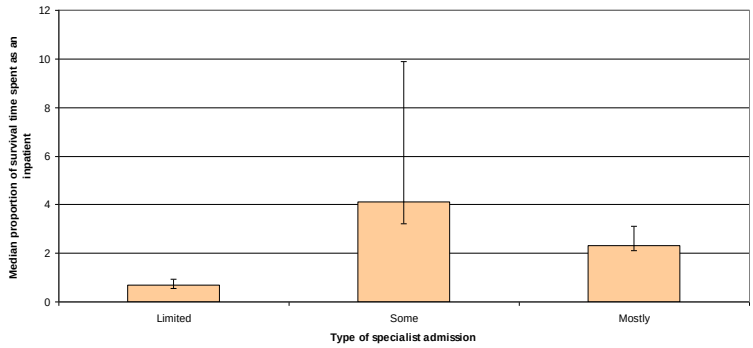


Figure 86: Median proportion of the treatment period spent as an inpatient, per patient



11.4.4 Health service costs

The total cost of admissions during treatment reflect the patterns seen in previous analyses, with patients receiving some specialist care having the highest overall cost, followed by patients with mostly specialist care and those with limited input having the lowest total cost (Figure 87). There is very little variation between the groups when examining the cost per admission (Figure 88).

Figure 87: Median total cost of admissions per patient during treatment, by secialist group

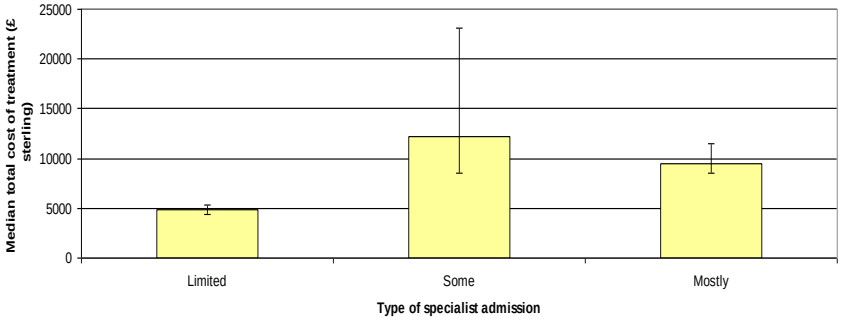
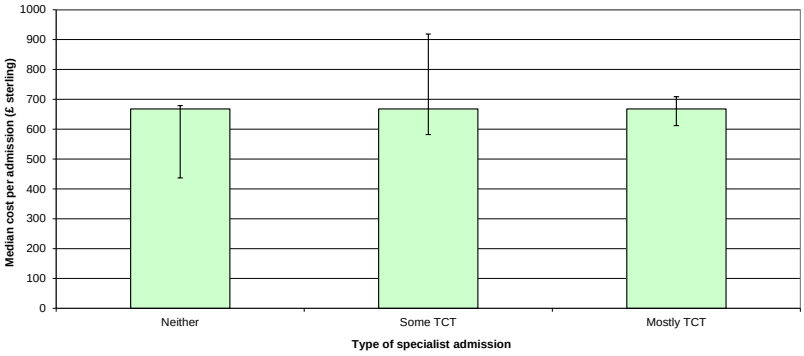


Figure 88: Median cost per admission

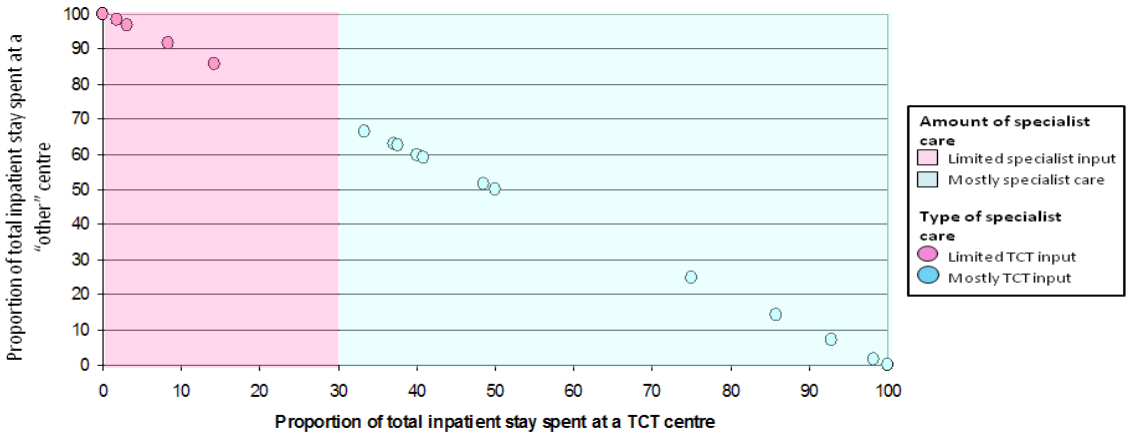


Chapter 12 Melanoma and skin carcinoma

12.1 Specialist care

The proportion of total inpatient time during treatment spent at a specialist centre was compared to the time spent at any other type of hospital for melanoma patients. Due to the low level of admissions and the distribution of patients when comparing specialist to non-specialist care it was decided that specialist care for melanoma and skin carcinoma patients was anything over 30%.

Figure 89: Assignment of melanoma and skin carcinoma patients to a "level" of specialist care using the proportion of inpatient time spent in a specialist centre

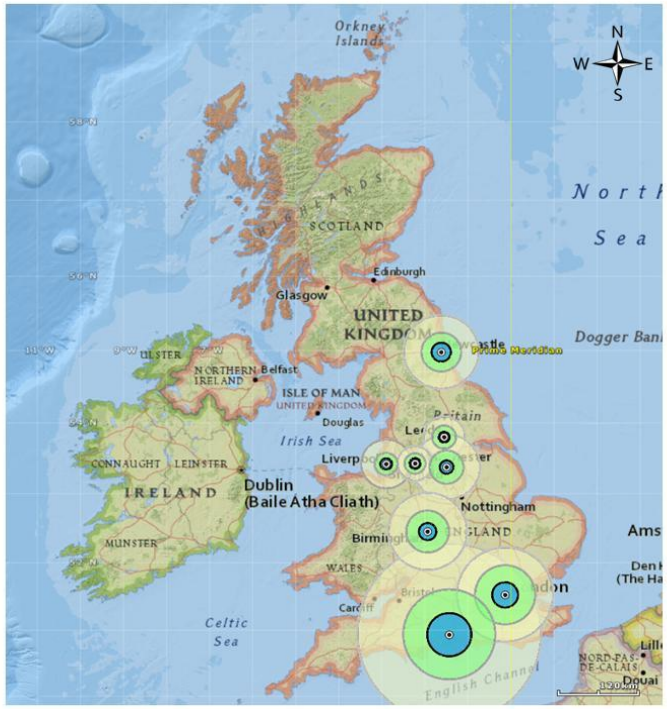


12.2 Access to specialist care

12.2.1 Hospital catchment areas

With the exception of Newcastle, all TCT units showed a smaller actual catchment area (Map 20) than theoretical one (Map 21). Leeds and Newcastle had the smallest proportion of patients, for whom they were the closest centre and who were not admitted to a TCT centre during their treatment (Table 95). Overall, very few melanoma and skin carcinoma patients were admitted to a TCT centre during treatment and very few patients were admitted to a centre other than their closest one (Table 95).

Map 21: Site of TCT centres in England (2001-2009) and the residential location of melanoma and skin carcinoma patients closest to each



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Key
- Location of TCT centres
- Proportion of melanoma patients
  - 25% of cases
  - 50% of cases
  - 75% of cases

Map 20: Site of TCT centres in England (2001-2009) and the residential location of melanoma and skin carcinoma patients admitted to each

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Key
- Location of TCT centres
- Proportion of melanoma patients
  - 25% of cases
  - 50% of cases
  - 75% of cases

Table 95: Numbers of melanoma and skin carcinoma patients closest to each TCT centre, and the centre actually attended

		NHS trust with a TCT unit to which the patient was admitted																		
		Alder Hey Children's NHS Foundation Trust		Leeds Teaching Hospitals NHS Trust		Sheffield Teaching Hospitals NHS Foundation Trust		University Hospital Southampton NHS Foundation Trust		The Christie NHS Foundation Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		University College London Hospitals NHS Foundation Trust		University Hospitals Birmingham NHS Foundation Trust		None		Total
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Closest NHS trust with a TCT unit at the time of admission	Alder Hey Children's NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*1*	**2**	*1.9*	**0**	*1.8*	**1**	*1*	**101**	*96*	**105**
	Leeds Teaching Hospitals NHS Trust	**0**	*0*	**30**	*33*	**1**	*1.1*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**61**	*66*	**92**
	Sheffield Teaching Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**35**	*28*	**0**	*0*	**2**	*1.6*	**0**	*0*	**0**	*0*	**0**	*0*	**86**	*70*	**123**
	University Hospital Southampton NHS Foundation Trust	**0**	*0*	**0**	*0*	**3**	*1.3*	**13**	*5.6*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*0.4*	**215**	*93*	**232**
	The Christie NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**32**	*38*	**0**	*0*	**0**	*0*	**2**	*2.4*	**51**	*60*	**85**
	The Newcastle upon Tyne Hospitals NHS Foundation Trust	**0**	*0*	**1**	*1.5*	**0**	*0*	**0**	*0*	**1**	*1.5*	**22**	*33*	**0**	*51*	**0**	*0*	**42**	*64*	**66**
	University College London Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**1**	*0.4*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*12*	**0**	*0*	**271**	*99*	**273**
	University Hospitals Birmingham NHS Foundation Trust	**0**	*0*	**0**	*0*	**1**	*0.7*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**39**	*27*	**103**	*72*	**143**
	Total	**0**		**31**		**41**		**13**		**36**		**24**		**1**		**43**		**930**		**1119**

Both increasing travel distance and a diagnosis of skin carcinoma rather than melanoma decreased the odds of admission to a TCT centre during treatment, however only travel distance was statistically significant and each 5km increase was associated with an 11% decrease in the likelihood of admission(OR 0.89 95%CI 0.84-0.94)(Table 96).

Table 96: Likelihood of admission to a TCT centre for melanoma and skin carcinoma patients

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	0.71	0.19	0.43	1.19
Age at diagnosis		1.08	0.17	0.97	1.21
Diagnostic group	Melanoma	1.00			
	Skin carcinoma	0.45	0.02	0.23	0.90
Deprivation	Most deprived	1.00			
	2	1.11	0.81	0.48	2.56
	3	1.20	0.67	0.52	2.77
	4	1.17	0.71	0.51	2.66
	Most affluent	1.35	0.45	0.62	2.95
Distance to nearest TCT centres (increase of 5km)		0.89	<0.01	0.84	0.94

12.2.2 Geographical distribution of patients

In all 31 networks the majority of melanoma patients received limited specialist TCT inpatient care (Table 97). This may have more to do with the nature of the disease, however, than referral patterns and healthcare structure as many patients (particularly with early stage disease) are treated on an outpatient basis. Very few melanoma patients are admitted during the course of treatment and the majority of interventions are undertaken as outpatients.

Table 97: Cancer network of residence at diagnosis and level of specialist inpatient care, melanoma and skin carcinoma (highlighted sections represent the highest proportion of patients for each cancer network)

	Limited		Mostly TCT		Number of patients
	n	%	n	%	
Lancashire & South Cumbria	51	98.1	1	1.9	52
Greater Manchester & Cheshire	76	83.5	15	16.5	91
Merseyside & Cheshire	50	100.0	0	0.0	50
Yorkshire	68	82.9	14	17.1	82
Humber & Yorskhire Coast	25	100.0	0	0.0	25
North Trent	68	87.2	10	12.8	78
Pan Birmingham	36	85.7	6	14.3	42
Arden	13	86.7	2	13.3	15
Mid Trent	54	98.2	1	1.8	55
Derby/ Burton	11	84.6	2	15.4	13
Leicestershire, Northants & Rutland	22	91.7	2	8.3	24
Mount Vernon	17	100.0	0	0.0	17
West London	11	100.0	0	0.0	11
North London	12	100.0	0	0.0	12
North East London	19	100.0	0	0.0	19
South East London	9	100.0	0	0.0	9
South West London	35	100.0	0	0.0	35
Peninsula	70	100.0	0	0.0	70
Dorset	20	100.0	0	0.0	20
Avon, Somerest & Wiltshire	46	97.9	1	2.1	47
3 Counties	8	88.9	1	11.1	9
Thames Valley	32	100.0	0	0.0	32
Central South Coast	37	100.0	0	0.0	37
Surrey, West Sussex & Hampshire	21	100.0	0	0.0	21
Sussex	28	100.0	0	0.0	28
Kent & Medway	14	100.0	0	0.0	14
Greater Midlands	38	88.4	5	11.6	43
North of England	93	97.9	2	2.1	95
Anglia	44	97.8	1	2.2	45
Essex	18	100.0	0	0.0	18
Wales	3	100.0	0	0.0	3
Unknown	6	85.7	1	14.3	7
Total	1,055	94.3	64	5.7	1,119

12.2.3 High volume centres

Few melanoma patients are admitted to hospital during the course of their treatment. A much wider number of trusts admitted patients from this diagnostic group during their treatment, with the Sheffield Teaching Hospitals NHS Trust (ranked 1st in terms of number of patients) admitting 39 (3.5%) of the total number (Table 98). As with all the other diagnostic groups the majority of TCT units are in the top 15 (5 out of 8).

The trust with the greatest number of admissions was St Helens and Knowsley. This is a large teaching hospital and works as a specialist burns and plastic surgery centre for a population of four million. This specialisation may go some way to explain why admissions to this trust are so much higher than the next closest (6.1% versus 4.4%) (Table 99). Again five out of the eight TCT units are seen in the top 15. However the admission numbers are much lower in this diagnostic group than in any other, with the trust ranked 15th only having 37 admissions.

Table 98: Number of melanoma patients admitted to each NHS trust during the treatment period (top 15 only)

Rank	NHS Trust	Number of patients n	%
1	Sheffield Teaching Hospitals NHS Foundation Trust	39	*3.5*
2	St George's Healthcare NHS Trust	36	*3.2*
2	University Hospitals Birmingham NHS Foundation Trust	36	*3.2*
4	The Christie NHS Foundation Trust	34	*3.0*
5	Nottingham University Hospitals NHS Trust	33	*2.9*
6	St Helens and Knowsley Hospitals NHS Trust	31	*2.8*
7	Lancashire Teaching Hospitals NHS Foundation Trust	30	*2.7*
7	Leeds Teaching Hospitals NHS Trust	30	*2.7*
9	North Bristol NHS Trust	26	*2.3*
9	University Hospital of South Manchester NHS Trust	26	*2.3*
11	Oxford Radcliffe Hospitals NHS Trust	24	*2.1*
12	Plymouth Hospitals NHS Trust	22	*2.0*
12	South Tees Hospitals NHS Foundation Trust	22	*2.0*
12	The Newcastle upon Tyne Hospitals NHS Foundation Trust	22	*2.0*
15	Royal Devon & Exeter NHS Foundation Trust	19	*1.7*
	Total number of patients	1,119	

TCT centre

Table 99: Number of admissions to each NHS trust during the treatment period, melanoma patients

Rank	NHS Trust	Number of admissions n	%
1	St Helens and Knowsley Hospitals NHS Trust	113	*6.1*
2	The Christie NHS Foundation Trust	81	*4.4*
3	Sheffield Teaching Hospitals NHS Foundation Trust	68	*3.7*
4	Oxford Radcliffe Hospitals NHS Trust	61	*3.3*
4	University Hospitals Birmingham NHS Foundation Trust	61	*3.3*
6	Nottingham University Hospitals NHS Trust	60	*3.2*
7	Lancashire Teaching Hospitals NHS Foundation Trust	59	*3.2*
8	St George's Healthcare NHS Trust	54	*2.9*
9	Leeds Teaching Hospitals NHS Trust	53	*2.9*
10	Royal Devon & Exeter NHS Foundation Trust	41	*2.2*
11	North Bristol NHS Trust	39	*2.1*
11	Plymouth Hospitals NHS Trust	39	*2.1*
11	The Newcastle upon Tyne Hospitals NHS Foundation Trust	39	*2.1*
11	South Tees Hospitals NHS Foundation Trust	38	*2.0*
15	Royal Cornwall Hospitals NHS Trust	37	*2.0*
	Total number of admissions	1,854	

TCT centre

12.3 Variation in the uptake of specialist care

The distribution of patient characteristics between the specialist care groups for patients diagnosed with melanoma or skin carcinoma was similar (Table 100). A higher proportion of patients who received mostly specialist care had been diagnosed with malignant melanoma than those who received limited specialist input. The distribution of age groups, gender, deprivation and treatment was broadly similar across the groups.

Table 100: Melanoma patient details by amount of specialist inpatient care

		Limited		Mostly TCT			
		n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	268	*25.4*	*10*	*15.6*	278	
	20-24	787	*74.6*	*54*	*84.4*	841	*0.13*
Gender	**Male**	366	*34.7*	*24*	*37.5*	390	
	Female	689	*65.3*	*40*	*62.5*	729	*0.71*
Diagnostic group	**Melanoma**	833	*79.0*	*54*	*84.4*	887	
	Skin carcinoma	222	*21.0*	*10*	*15.6*	232	*0.02*
Deprivation	**Most affluent**	214	*20.3*	*17*	*26.6*	231	
	4	219	*20.8*	*12*	*18.8*	231	
	3	208	*19.7*	*10*	*15.6*	218	
	2	219	*20.8*	*12*	*18.8*	231	
	Most deprived	186	*17.6*	*12*	*18.8*	198	
	Unknown	9	*0.9*	*1*	*1.6*	10	*0.87*
Alive at censor	**Yes**	1,038	*98.4*	*60*	*93.8*	1,098	
	No	17	*1.6*	*4*	*6.3*	21	*<0.01*
Treatment received	**Surgery**	754	*71.5*	*39*	*60.9*	793	
	Surgery & additonal therapy	33	*3.1*	*4*	*6.3*	37	
	Chemoradiotherapy	3	*0.3*	*2*	*3.1*	5	
	None	265	*25.1*	*19*	*29.7*	284	*<0.01*
Total (number of patients)		1,055		64		1,119	

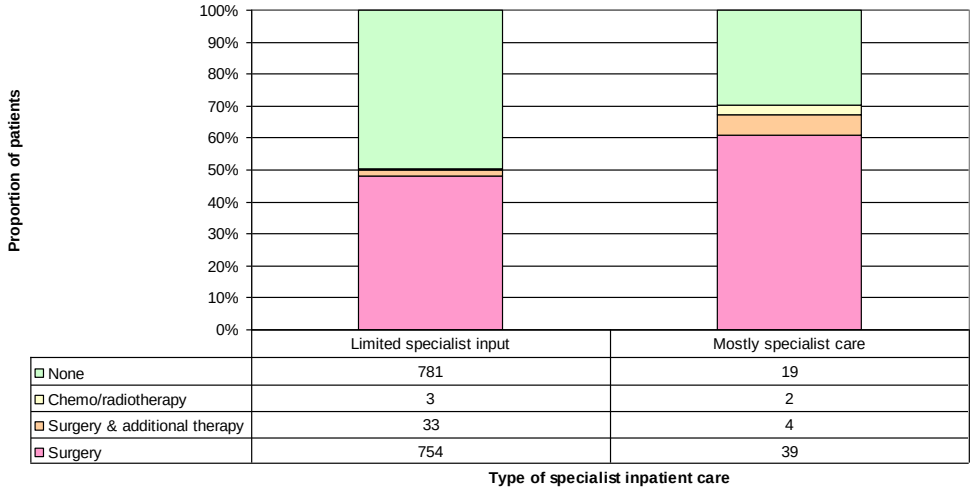
12.4 Patient outcomes

12.4.1 Treatment received

The treatment for melanoma and skin carcinoma patients was difficult to quantify as the majority of patients did not have any admissions during the treatment period. The protocols and guidelines in place for both melanoma and skin carcinoma mean that it is possible for the majority of therapy to be undertaken in an outpatient setting. A large number of patients have had an excision which leads to diagnosis, this is often a total excision meaning that no further treatment is required.

This is reflected in the summary of the treatment received shown in Figure 90. Approximately half of all patients with limited specialist input were recorded as having no treatment, the remaining patients had surgery with or without chemo-radiotherapy. The proportion of patients who had received mainly specialist care who were recorded as having no treatment was much smaller (circa 30%), a greater proportion of these patients were reported as having had surgery with or without chemo-radiotherapy.

Figure 90: Treatment received, by specialist group



12.4.2 Survival

Survival for patients diagnosed with a melanoma or skin carcinoma was approaching 100% at three years (Figure 91). Very few patients with limited specialist input had died whilst survival for those receiving mostly specialist care was over 80% at three years (Figure 92).

Figure 91: Survival to three years from diagnosis, by diagnostic subtype of skin cancer

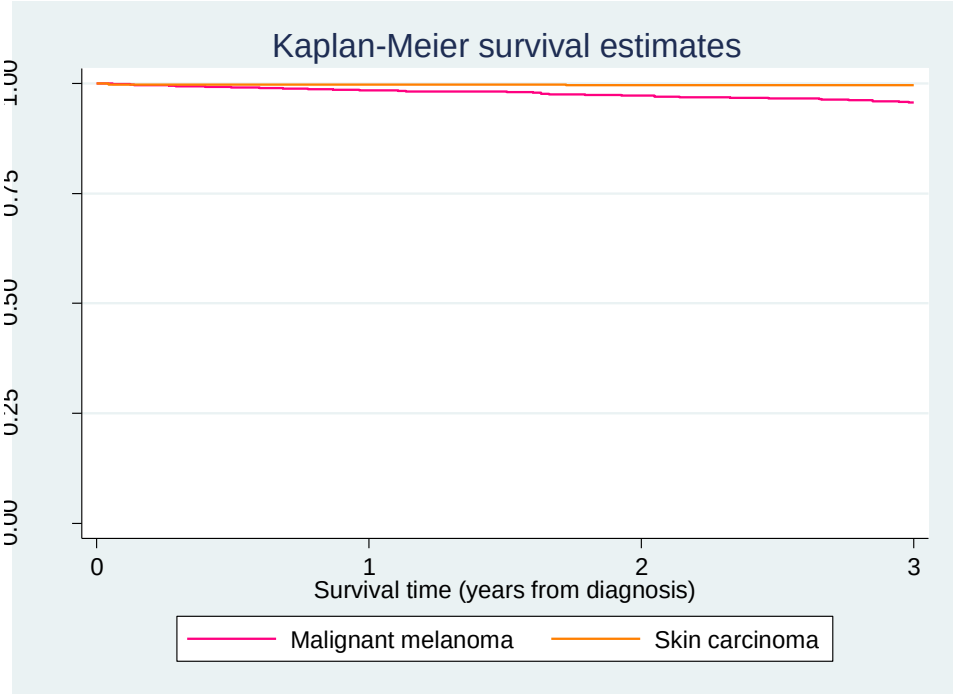
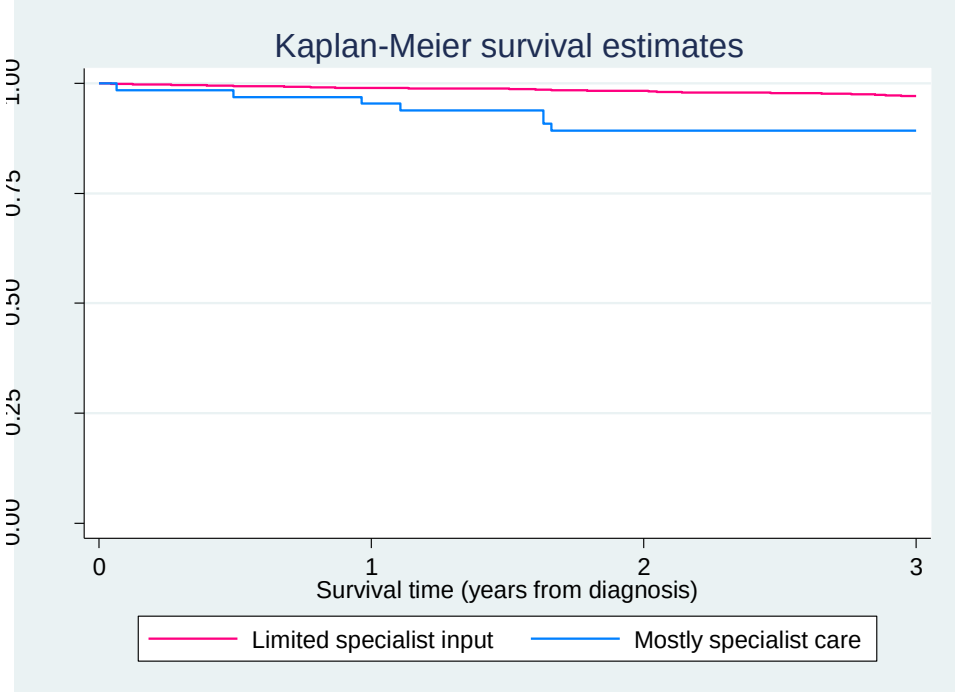


Figure 92: Survival to three years by amount to specialist care received, melanoma patients



The proportional hazards assumption was shown to hold for each variable included in the model individually and also for the model as a whole (Table 101). A likelihood ratio test showed that the inclusion of a non-linear term for age had no benefit when compared to age as a continuous variable (p=0.44).

Table 101: Results of the proportional hazards test (stphtest)

		rho	χ2	Prob> χ2
Age at diagnosis		-0.17	1.30	0.25
Gender	**Male**	1.00		
	Female	0.14	1.10	0.30
Year of diagnosis		0.07	0.24	0.63
Deprivation	**1 (Most deprived)**	1.00		
	2	-0.14	0.92	0.34
	3	-0.14	0.97	0.32
	4	-0.14	0.96	0.33
	5 (Most affluent)	0.04	0.08	0.78
Diagnostic subgroup	**Melanoma**	1.00		
	Skin carcinoma	-0.14	0.99	0.32
Amount of specialist	**Limited**	1.00		
	Mostly	-0.14	1.05	0.31
Global test			8.49	0.46

Several variables were shown to be statistically significantly associated with the risk of death. Female gender was associated with a sizable decreased risk of death (83%) compared to male patients (HR 0.17 95%CI 0.09-0.32). A diagnosis of skin carcinoma had a similar effect when compared to a diagnosis of melanoma with a decrease of 91% (HR 0.09 95%CI 0.02-0.37).

Receiving mostly specialist care was linked to a three-fold increased risk of death when compared to patients who received only limited specialist care (HR 3.65 95%CI 1.6308.19) (Table 102).

Table 102: Cox regression model for melanoma and skin carcinoma

				Confidence intervals	
		Haz. Ratio	*p value*	Lower 95%	Upper 95%
Age at diagnosis		0.97	0.57	0.86	1.08
Gender	**Male**	1.00			
	Female	0.17	<0.01	0.09	0.32
Year of diagnosis		0.95	0.56	0.81	1.12
Deprivation	**Most deprived**	1.00			
	2	1.40	0.51	0.51	3.89
	3	2.19	0.10	0.86	5.63
	4	1.18	0.74	0.43	3.26
	Most affluent	0.92	0.88	0.33	2.55
Diagnostic subgroup	**Melanoma**	1.00			
	Skin carcinoma	0.09	<0.01	0.02	0.37
Amount of specialist care	**Limited**	1.00			
	Mostly	3.65	<0.01	1.63	8.19

12.4.3 Health service usage

The peak in admissions for melanoma and skin carcinoma patients was difficult to interpret (Figure 93) as there were, overall, so few admissions. There is a distinct peak in admissions during the week of diagnosis and up to a month after this, before the admissions tail off for patients with limited specialist input. Patients with mostly specialist care show a much smaller peak in admissions around the same time from diagnosis.

Figure 93: Number of admissions per week, by time from diagnosis

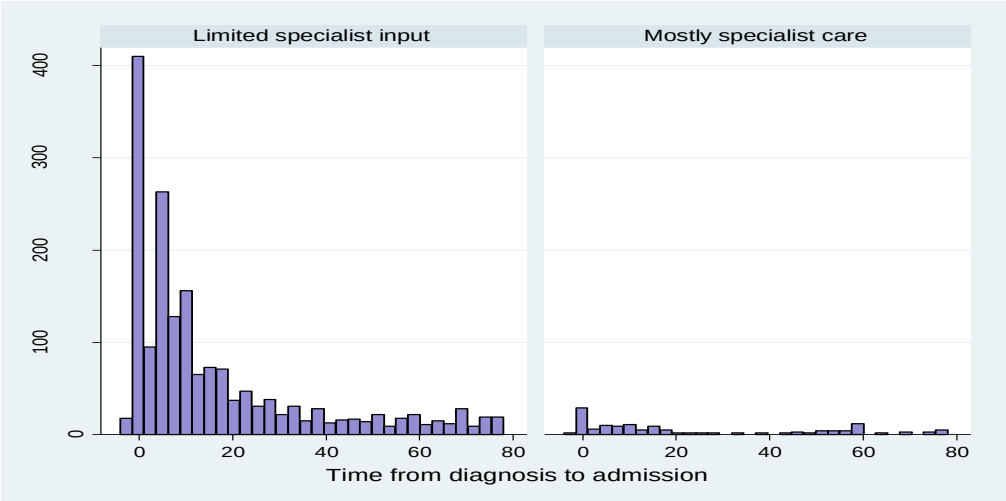


Table 103: Health service usage during treatment, by amount of specialist care

	Specialist group	Median	Confidence intervals Lower 95%	Upper 95%
Number of admissions during treatment	**Limited**	1	1	1
	Mostly	2	2	2
Proportion of admissions during treatment which were unplanned	**Limited**	0	0	0
	Mostly	0	0	0
Proportion of treatment period spent as an inpatient	**Limited**	0.0	0.0	0.0
	Mostly	0.5	0.4	0.7

12.4.4 Health service costs

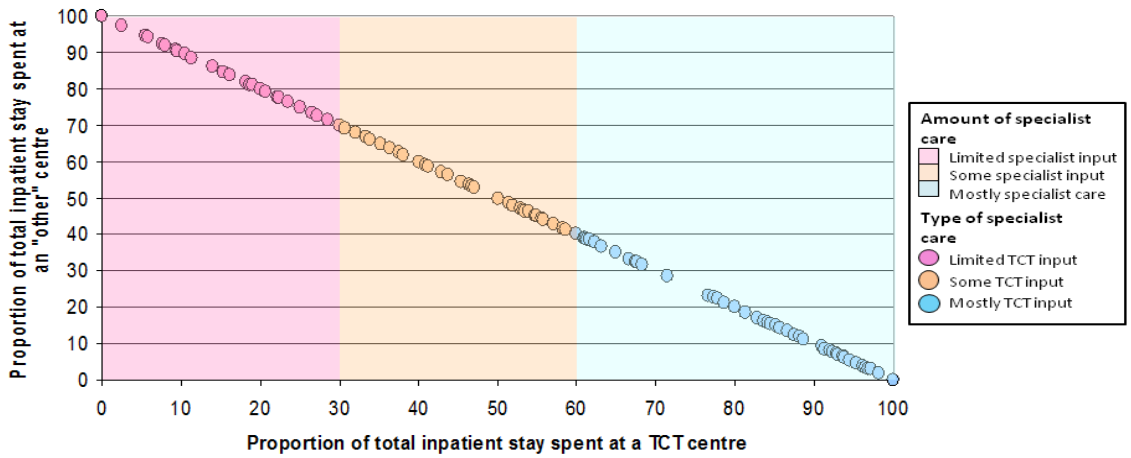
Due to the low proportion of patients admitted during their treatment it was not possible to compare costs for this group.

Chapter 13 Carcinomas

13.1 Specialist care

The proportion of total inpatient time during treatment spent at a TCT centre was compared to the time spent at any other type of hospital for carcinoma patients. Due to the wide range of diagnoses in this group and the small number of patients in each sub-group it was not possible to assess site-specific specialist centres for these patients. This means that for carcinoma patients the proportion of treatment received at a TCT centre was compared to treatment at any other NHS facility.

Figure 94: Assignment of carcinoma patients to a "level" of specialist care using the proportion of inpatient time spent in a specialist centre



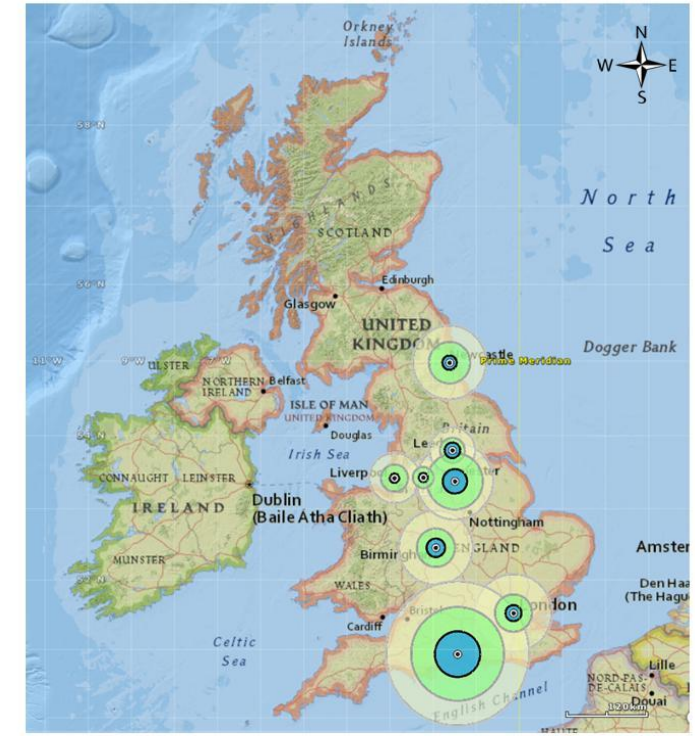
13.2 Access to specialist care

13.2.1 Hospital catchment areas

All TCT units showed a smaller actual catchment area of carcinoma patients (Map 22) than theoretical one (Map 23).

Leeds, Newcastle and the Christie had the smallest proportion of patients, for whom they were the closest centre, who were not admitted to a TCT centre during their treatment (Table 95). Overall, very few carcinoma patients were admitted to a TCT centre during treatment and very few patients were admitted to a centre other than their closest one (Table 104).

Map 23: Site of TCT centres in England (2001-2009) and the residential location of carcinoma patients closest to each



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Key
- *Location of TCT centres*

Proportion of carcinoma patients
- *25% of cases*
- *50% of cases*
- *75% of cases*

Map 22: Site of TCT centres in England (2001-2009) and the residential location of carcinoma patients admitted to each

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Key
- *Location of TCT centres*

Proportion of carcinoma patients
- *25% of cases*
- *50% of cases*
- *75% of cases*

Table 104: Numbers of carcinoma patients closest to each TCT centre, and the centre actually attended

		NHS trust with a TCT unit to which the patient was admitted																		
		Alder Hey Children's NHS Foundation Trust		Leeds Teaching Hospitals NHS Trust		Sheffield Teaching Hospitals NHS Foundation Trust		University Hospital Southampton NHS Foundation Trust		The Christie NHS Foundation Trust		The Newcastle upon Tyne Hospitals NHS Foundation Trust		University College London Hospitals NHS Foundation Trust		University Hospitals Birmingham NHS Foundation Trust		None		Total
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Closest NHS trust with a TCT unit at the time of admission	Alder Hey Children's NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**10**	*13*	**0**	*0*	**0**	*0*	**0**	*0*	**66**	*87*	**76**
	Leeds Teaching Hospitals NHS Trust	**0**	*0*	**62**	*63*	**2**	*2*	**0**	*0*	**1**	*1*	**0**	*0*	**0**	*0*	**0**	*0*	**34**	*34*	**99**
	Sheffield Teaching Hospitals NHS Foundation Trust	**0**	*0*	**1**	*1*	**35**	*33*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*1*	**68**	*65*	**105**
	University Hospital Southampton NHS Foundation Trust	**0**	*0*	**2**	*0.9*	**2**	*0.9*	**28**	*13*	**1**	*0.5*	**0**	*0*	**1**	*0*	**1**	*0.5*	**186**	*84*	**221**
	The Christie NHS Foundation Trust	**0**	*0*	**0**	*0*	**1**	*0.8*	**0**	*0*	**61**	*50*	**0**	*0*	**0**	*0*	**2**	*1.7*	**57**	*47*	**121**
	The Newcastle upon Tyne Hospitals NHS Foundation Trust	**0**	*0*	**1**	*1.2*	**0**	*0*	**0**	*0*	**0**	*0*	**34**	*40*	**0**	*47*	**0**	*0*	**50**	*59*	**85**
	University College London Hospitals NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**3**	*0.7*	**1**	*0.2*	**0**	*0*	**27**	*12*	**0**	*0*	**397**	*93*	**428**
	University Hospitals Birmingham NHS Foundation Trust	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**1**	*0*	**50**	*27*	**131**	*72*	**182**
	Total	**0**		**66**		**40**		**31**		**74**		**34**		**29**		**54**		**989**		**1317**

As with all other cancer sites, increasing distance from home to a TCT centre was associated with decreasing odds of admission to a TCT centre, with each 5km increase in distance having a 4% decreased likelihood of admission (OR 0.96 95%CI 0.95-0.97). A diagnosis of breast cancer significantly decreased the odds of a TCT centre admission by 52% (OR 0.48 95%CI 0.25-0.90) whilst a diagnosis of carcinoma of "other and ill-defined sites" significantly increased the odds of a TCT centre admission by 69% (OR 1.69 95%CI 1.10-2.60) (Table 105).

Table 105: Likelihood of admission to a TCT centre for carcinoma patients

		Odds ratio	p value	Lower 95%	Upper 95%
Gender	Male	1.00			
	Female	1.11	0.48	0.84	1.46
Age at diagnosis		0.97	0.18	0.93	1.01
Diagnostic group	Thyroid	1.00			
	Head and neck	0.88	0.56	0.58	1.34
	Trachea, bronchus, lung and pleura	0.63	0.21	0.31	1.30
	Breast	0.48	0.02	0.25	0.90
	GU tract	1.04	0.82	0.77	1.40
	GI tract	0.84	0.32	0.60	1.18
	Other & ill defined sites	1.69	0.02	1.10	2.60
Deprivation	Most deprived	1.00			
	2	0.72	0.05	0.52	1.00
	3	1.13	0.47	0.81	1.57
	4	0.83	0.29	0.59	1.18
	Most affluent	0.95	0.76	0.67	1.34
Distance to nearest TCT centres (increase of 5km)		0.96	<0.01	0.95	0.97

13.2.2 Geographical distribution of patients

The vast majority of networks see the bulk of their TYA carcinoma patients being treated with limited TCT specialist inpatient care, in fact only patients in the Yorkshire and North Trent Networks spent the majority of their inpatient time in a TCT centre (Table 106).

Table 106: Cancer network of residence at diagnosis and level of specialist inpatient care, carcinomas (highlighted sections represent the highest proportion of patients for each cancer network)

	Limited		Some TCT		Mostly TCT		Number of patients
	n	%	n	%	n	%	
Lancashire & South Cumbria	38	80.9	5	10.6	4	8.5	47
Greater Manchester & Cheshire	59	60.8	17	17.5	21	21.6	97
Merseyside & Cheshire	46	97.9	0	0.0	1	2.1	47
Yorkshire	25	30.9	17	21.0	39	48.1	81
Humber & Yorkshire Coast	26	89.7	1	3.4	2	6.9	29
North Trent	20	46.5	2	4.7	21	48.8	43
Pan Birmingham	28	49.1	10	17.5	19	33.3	57
Arden	26	89.7	1	3.4	2	6.9	29
Mid Trent	38	97.4	1	2.6	0	0.0	39
Derby/ Burton	21	95.5	0	0.0	1	4.5	22
Leicestershire, Northants & Rutland	29	96.7	1	3.3	0	0.0	30
Mount Vernon	26	92.9	1	3.6	1	3.6	28
West London	50	94.3	0	0.0	3	5.7	53
North London	22	78.6	0	0.0	6	21.4	28
North East London	40	95.2	1	2.4	1	2.4	42
South East London	34	97.1	0	0.0	1	2.9	35
South West London	46	93.9	0	0.0	3	6.1	49
Peninsula	42	100.0	0	0.0	0	0.0	42
Dorset	25	100.0	0	0.0	0	0.0	25
Avon, Somerset & Wiltshire	58	100.0	0	0.0	0	0.0	58
3 Counties	22	91.7	0	0.0	2	8.3	24
Thames Valley	54	100.0	0	0.0	0	0.0	54
Central South Coast	56	100.0	0	0.0	0	0.0	56
Surrey, West Sussex & Hampshire	24	96.0	1	4.0	0	0.0	25
Sussex	20	95.2	0	0.0	1	4.8	21
Kent & Medway	42	97.7	0	0.0	1	2.3	43
Greater Midlands	35	87.5	1	2.5	4	10.0	40
North of England	82	98.8	0	0.0	1	1.2	83
Anglia	52	98.1	0	0.0	1	1.9	53
Essex	30	96.8	0	0.0	1	3.2	31
Wales	1	50.0	0	0.0	1	50.0	2
Unknown	4	100.0	0	0.0	0	0.0	4
Total	1,121		59		137		1,317

13.2.3 High volume centres

Carcinoma patients have a much wider range of diagnoses than that which is seen in any of the previous groups. This would suggest that a similar pattern would be seen in this group as was seen in melanoma and skin carcinoma, a large number of trusts treating relatively few patients. All the trusts seen in the top 15, both in terms of patients and admissions, are large teaching hospitals and cancer centres (Table 107 & Table 108). In both cases seven out of eight TCT centres are seen in the top 15.

Table 107: Number of carcinoma patients admitted to each NHS trust during the treatment period (top 15 only)

Rank	NHS Trust	Number of patients n	%
1	The Christie NHS Foundation Trust	73	*5.5*
2	Leeds Teaching Hospitals NHS Trust	65	*4.9*
3	The Royal Marsden NHS Foundation Trust	63	*4.8*
4	University Hospital Birmingham NHS Foundation Trust	51	*3.9*
5	Barts and the London NHS Trust	44	*3.3*
6	Imperial College Healthcare NHS Trust	39	*3.0*
7	Sheffield Teaching Hospitals NHS Foundation Trust	38	*2.9*
8	Nottingham University Hospitals NHS Trust	34	*2.6*
9	The Newcastle upon Tyne Hospitals NHS Foundation Trust	33	*2.5*
10	Cambridge University Hospitals NHS Foundation Trust	30	*2.3*
10	University Hospitals Bristol NHS Foundation Trust	30	*2.3*
12	University College London Hospitals NHS Trust	29	*2.2*
13	Guy's and St Tomas' NHS Foundation Trust	28	*2.1*
14	King's College Hospital NHS Foundation Trust	27	*2.1*
14	Oxford Radcliffe Hospitals NHS Trust	27	*2.1*
14	University Hospitals of Southampton NHS Trust	27	*2.1*
15	Gloucestershire Hospitals NHS Foundation Trust	26	*2.0*
	Total number of patients	1,317	

TCT centre

Table 108: Number of admissions to each NHS trust during the treatment period, carcinoma patients

Rank	NHS Trust	Number of admissions n	%
1	Leeds Teaching Hospitals NHS Trust	496	*5.2*
2	The Christie NHS Foundation Trust	483	*5.1*
3	The Royal Marsden NHS Foundation Trust	362	*3.8*
4	Nottingham University Hospitals NHS Trust	299	*3.2*
5	Sheffield Teaching Hospitals NHS Foundation Trust	293	*3.1*
6	University Hospitals Bristol NHS Foundation Trust	262	*2.8*
7	Lancashire Teaching Hospitals NHS Foundation Trust	247	*2.6*
8	Imperial College Healthcare NHS Trust	231	*2.4*
9	Gloucestershire Hospitals NHS Foundation Trust	230	*2.4*
10	Barts and the London NHS Trust	223	*2.4*
11	University Hospital Birmingham NHS Foundation Trust	221	*2.3*
12	The Newcastle upon Tyne Hospitals NHS Foundation Trust	217	*2.3*
13	Royal Devon & Exeter NHS Foundation Trust	166	*1.7*
14	University Hospitals of Southampton NHS Trust	155	*1.6*
15	University College London Hospitals NHS Trust	154	*1.6*
	Total number of admissions	9,486	

TCT centre

13.3 Variation in the uptake of specialist care

The majority of carcinoma patients were aged 20 to 24 at diagnosis, this ranged from 75.6% of patients with limited specialist input, to 65.7% of patients with mostly specialist care (Table 109). The gender distribution was similar across all three groups, although the proportion of male patients was slightly higher in the group with mostly specialist care.

The vast majority of patients were diagnosed with a genito-urinary (GU) tract tumour; this is reflected in the distribution of diagnoses for patients with limited specialist input. In contrast, over half (57.6%) of all patients with some specialist input had a thyroid carcinoma, whilst only 10.2% had a GU tract carcinoma. The distribution in patients with mostly specialist care was more reflective of the overall pattern.

The majority of patients survived to the end of the treatment period (86.4% of patients with limited specialist input to 72.3% of patients with mostly specialist care).

Surgery, with or without chemo-radiotherapy, was the mainstay of treatment for this group, with well over half of all patients undergoing surgery. The major variation in treatment was seen in the use of chemo/radiotherapy without surgery, with was used in 38 cases (27.7%) in patients who have mainly specialist care, as opposed to 8.7% of cases with limited input and 16.7% of cases with some specialist input. A greater proportion of those with limited input had no treatment recorded than in any other group.

Table 109: Carcinoma patient details by amount of specialist inpatient care

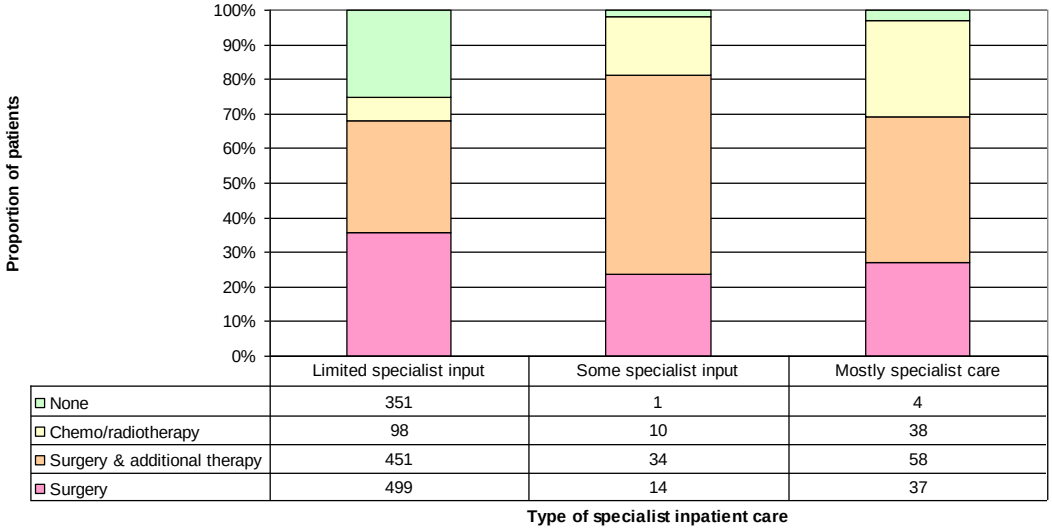
		Limited		Some TCT		Mostly TCT			
		n	%	n	%	n	%	Total	*p value*
Age at diagnosis	**15-19**	273	*24.4*	20	*33.9*	47	*34.3*	340	
	20-24	848	*75.6*	39	*66.1*	90	*65.7*	977	*0.01*
Gender	**Male**	295	*26.3*	15	*25.4*	44	*32.1*	354	
	Female	826	*73.7*	44	*74.6*	93	*67.9*	963	*0.21*
Diagnostic group	**Thyroid**	271	*24.2*	34	*57.6*	38	*27.7*	379	
	Head and neck	115	*10.3*	2	*3.4*	22	*16.1*	160	
	Trachea, bronchus, lung & pleura	33	*2.9*	1	*1.7*	7	*5.1*	45	
	Breast	66	*5.9*	3	*5.1*	5	*3.6*	77	
	Genito-urinary tract	312	*27.8*	6	*10.2*	28	*20.4*	458	
	Gastrointestinal tract	250	*22.3*	10	*16.9*	27	*19.7*	347	
	Other	74	*6.6*	3	*5.1*	10	*7.3*	129	*<0.01*
Deprivation	**Most affluent**	190	*16.9*	8	*13.6*	17	*12.4*	215	
	4	202	*18.0*	10	*16.9*	20	*14.6*	232	
	3	200	*17.8*	8	*13.6*	26	*19.0*	234	
	2	262	*23.4*	10	*16.9*	26	*19.0*	298	
	Most deprived	262	*23.4*	23	*39.0*	47	*34.3*	332	
	Unknown	5	*0.4*	0	*0.0*	1	*0.7*	6	*0.04*
Alive at end of treatment period	**Yes**	957	*85.4*	51	*86.4*	99	*72.3*	1,107	
	No	164	*14.6*	8	*13.6*	38	*27.7*	210	*<0.01*
Treatment received	**Surgery**	449	*40.1*	14	*23.7*	37	*27.0*	550	
	Surgery & additional therapy	451	*40.2*	34	*57.6*	58	*42.3*	543	
	Chemoradiotherapy	98	*8.7*	10	*16.9*	38	*27.7*	146	
	None	73	*6.5*	1	*1.7*	4	*2.9*	78	*<0.01*
Total (number of patients)		1,121	100	59	100	137	100	1,317	

13.4 Patient outcomes

13.4.1 Treatment received

The treatment received by patients diagnosed with a carcinoma varied by the amount of specialist inpatient treatment (Figure 95). Patients receiving some specialist input underwent surgery and chemo-radiotherapy as their modal treatment. Whilst those with limited input had a greater proportion undergoing surgery alone as an inpatient and a larger number of cases with no treatment reported as an inpatient. Of all the groups those with mostly specialist inpatient care had the greatest proportion of patients undergoing chemo-radiotherapy with no surgery recorded. This supports the previous findings which demonstrated a variation in both patient and tumour characteristics by specialist care group (Table 109).

Figure 95: Treatment received, by specialist group



	Limited specialist input	Some specialist input	Mostly specialist care
None	351	1	4
Chemo/radiotherapy	98	10	38
Surgery & additional therapy	451	34	58
Surgery	499	14	37

13.4.2 Survival

Survival for patients diagnosed with a carcinoma varied by diagnostic sub group (Figure 96) and amount of specialist care received (Figure 97). Patients diagnosed with a thyroid carcinoma had the highest survival whilst those diagnosed with a carcinoma of the gastrointestinal tract or 'other' carcinoma had similarly low survival to three years from diagnosis. Those with mostly specialist inpatient care had the lowest survival with approximately 60% surviving to three years from diagnosis, in contrast over 80% of those with limited or some specialist input survived to the same time point.

Figure 96: Survival to three years from diagnosis, by diagnostic subtype of carcinoma

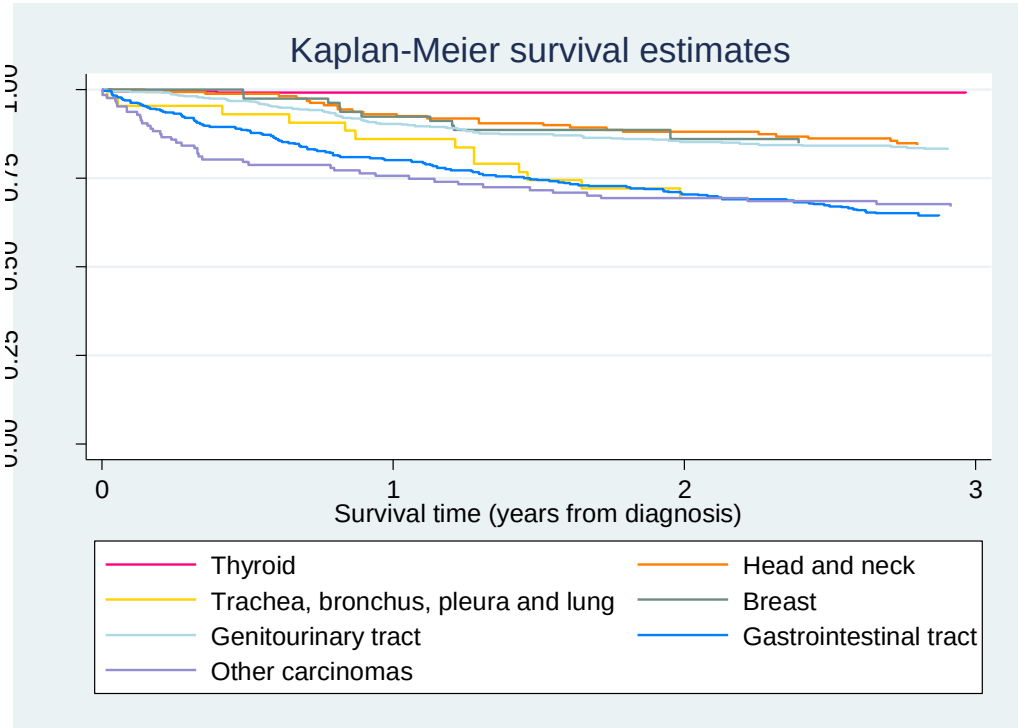
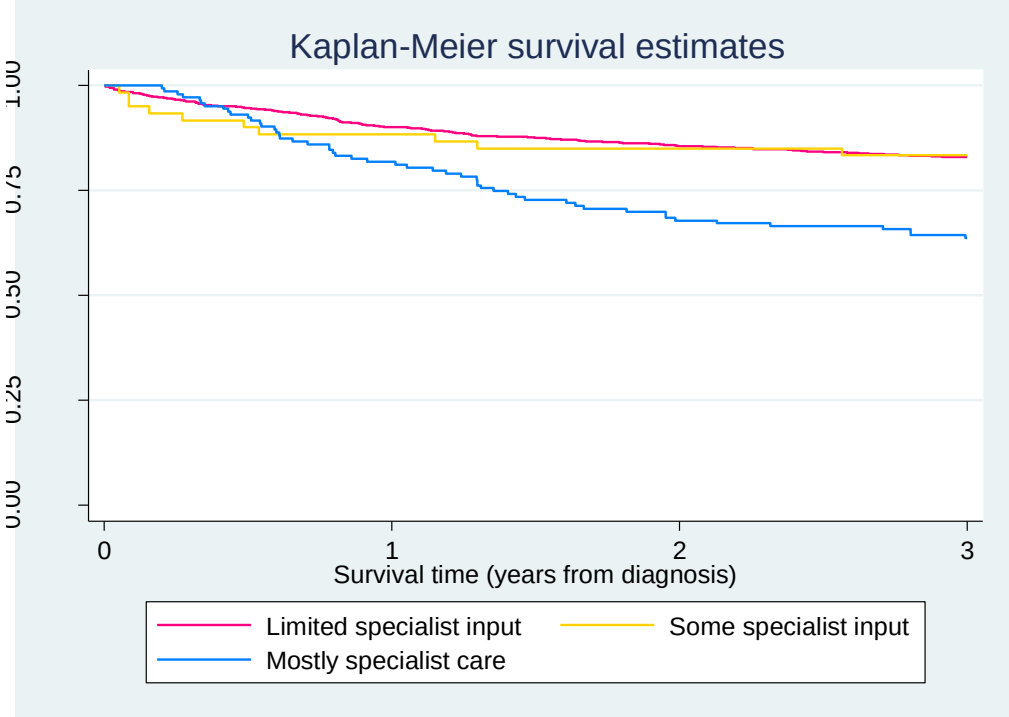


Figure 97: Survival to three years by amount to specialist care received, carcinoma patients



The results of the global test of the model showed that the proportional hazards assumption held, however inclusion of gender may cause some issues (Table 110). This could have been due to the distribution of diagnostic groups by gender. The results of a likelihood ratio test, comparing models using both linear and non-linear scales for age showed that there was no benefit to the inclusion of age as a categorical variable and so a continuous scale was used (p=0.69).

Table 110: Results of the proportional hazards test (stphtest)

		rho	χ2	Prob> χ2
Age at diagnosis		-0.11	3.34	0.07
Gender	**Male**	1.00		
	Female	0.12	5.13	0.02
Year of diagnosis		0.02	0.16	0.69
Deprivation	**1 (Most deprived)**	1.00		
	2	0.06	0.88	0.35
	3	0.00	0.00	0.99
	4	0.06	0.90	0.34
	5 (Most affluent)	0.00	0.00	0.97
Diagnostic subgroup	**Genitourinary tract**	1.00		
	Thyroid	0.01	0.02	0.88
	Head and neck	0.12	3.80	0.05
	Trachea, bronchus, lung and pleura	0.02	0.11	0.74
	Breast	0.01	0.05	0.82
	Gastrointestinal tract	0.07	1.54	0.21
	Other and ill defined sites	-0.04	2.00	0.16
Amount of specialist care	**Limited**	1.00		
	Some	-0.04	0.58	0.45
	Mostly	0.07	1.39	0.24
Global test			20.94	0.14

Female gender was associated with a statistically significant 66% decrease in the risk of death (HR 0.44 95%CI 0.33-0.59). A diagnosis of thyroid or head and neck carcinoma were associated with a decrease in risk of death of 96% and 42% respectively (HR 0.04 95%CI 0.01-0.11 and HR 0.58 95%CI 0.35- 0.94) when compared to genitourinary tumours. Diagnosis of a tumour of the gastrointestinal tract or other ill-defined sites was associated with a close to two--fold significant increase (HR 1.72 95%CI 1.23-2.39 and HR 2.02 95%CI 1.37-2.96). Receiving some or mostly specialist care led to an increased risk, but this was only significant for patients having mostly specialist care (HR 2.78 95%CI 2.02-3.18). Increasing affluence was associated with a decreased risk of death when compared to the most deprived group.

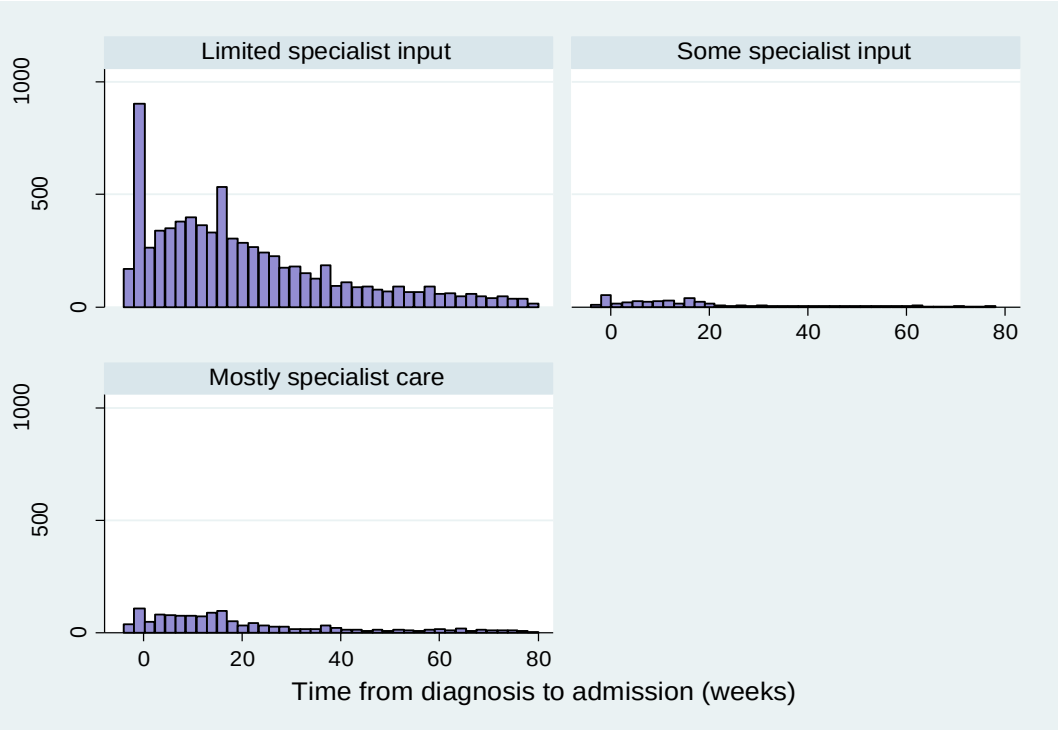
Table 111: Cox regression model for carcinoma

				Confidence intervals	
		Haz. Ratio	*p value*	Lower 95%	Upper 95%
Age at diagnosis		1.05	*0.06*	1.00	1.10
Gender	**Male**	1.00			
	Female	0.44	*<0.01*	0.33	0.59
Year of diagnosis		0.97	*0.34*	0.90	1.04
Deprivation	**Most deprived**	1.00			
	2	0.99	*0.97*	0.72	1.37
	3	0.96	*0.81*	0.68	1.35
	4	0.70	*0.06*	0.48	1.01
	Most affluent	0.76	*0.18*	0.51	1.13
Diagnostic subgroup	**Genitourinary tract**	1.00			
	Thyroid	0.04	*<0.01*	0.01	0.11
	Head and neck	0.58	*0.03*	0.35	0.94
	Trachea, bronchus, lung and pleura	1.04	*0.91*	0.54	2.01
	Breast	0.82	*0.54*	0.43	1.55
	Gastrointestinal tract	1.72	*<0.01*	1.23	2.39
	Other and ill defined sites	2.02	*<0.01*	1.37	2.96
Amount of specialist care	**Limited**	1.00			
	Some	1.55	*0.20*	0.79	3.05
	Mostly	2.78	*<0.01*	2.02	3.81

13.4.3 Health service usage

There is a clear peak in admissions for patients with limited specialist input at the week of diagnosis and a smaller peak five weeks post diagnosis (Figure 98). The pattern is more difficult to interpret for the other specialist care groups where the peak is less distinct.

Figure 98: Number of admissions per week, by time from diagnosis



Patients receiving mostly specialist care had the highest number of admissions during treatment (Figure 99) and spent the largest amount of the treatment period as an inpatient (Figure 101). The proportion of unplanned admissions (Figure 100) was similar for all groups.

Figure 99: Median number of admissions per patient during treatment, by specialist group

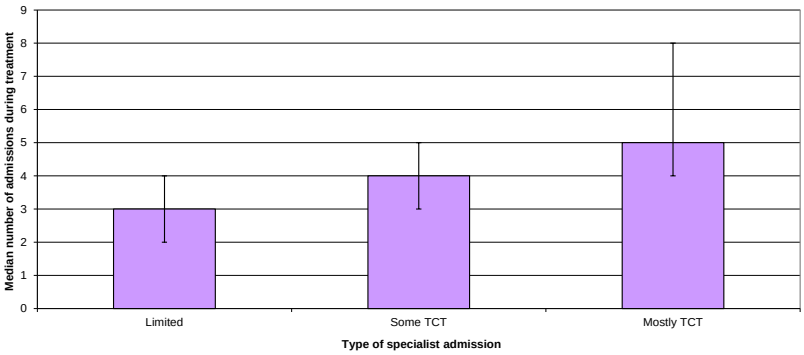


Figure 100: Median proportion of admissions, per patient, during treatment which were unplanned

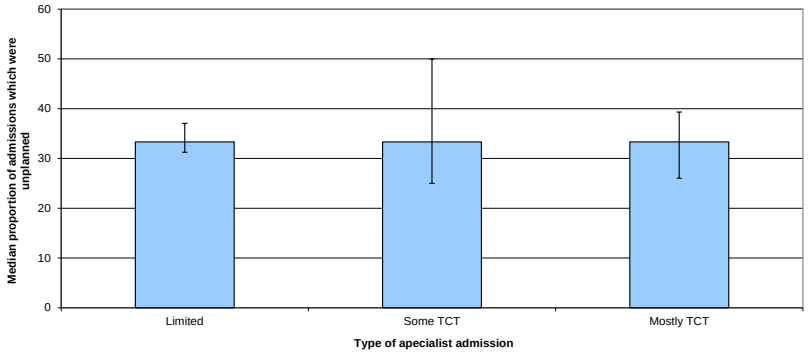
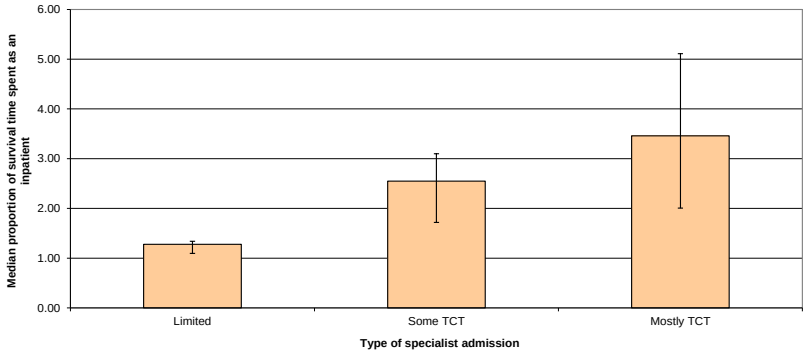


Figure 101: Median proportion of the treatment period spent as an inpatient, per patient



13.4.4 Health service costs

Patients who received mostly specialist care had the highest overall cost of admissions during the treatment period, reflective of the fact that they had the highest median number of admissions (Figure 102). The median cost per admission for this group was the lowest, however, with patients receiving some specialist care having a higher cost per admission (Figure 103).

Figure 102: Median total cost of admissions during treatment, per patient

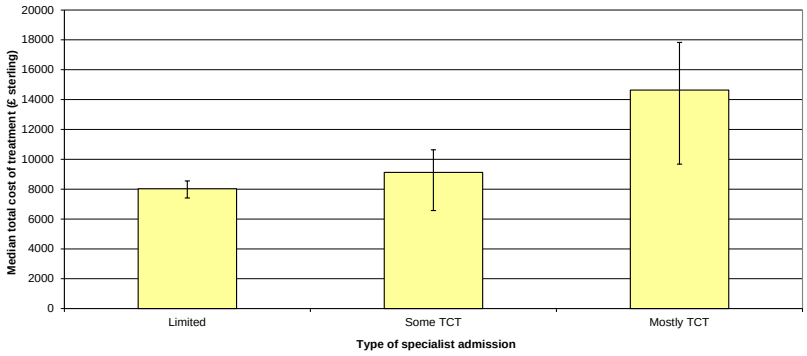
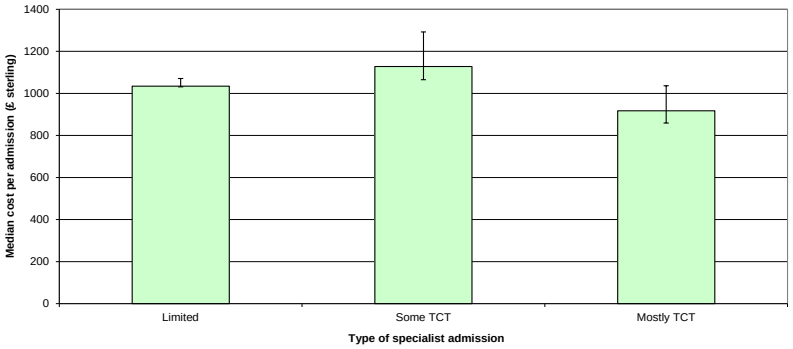


Figure 103: Median cost per admission



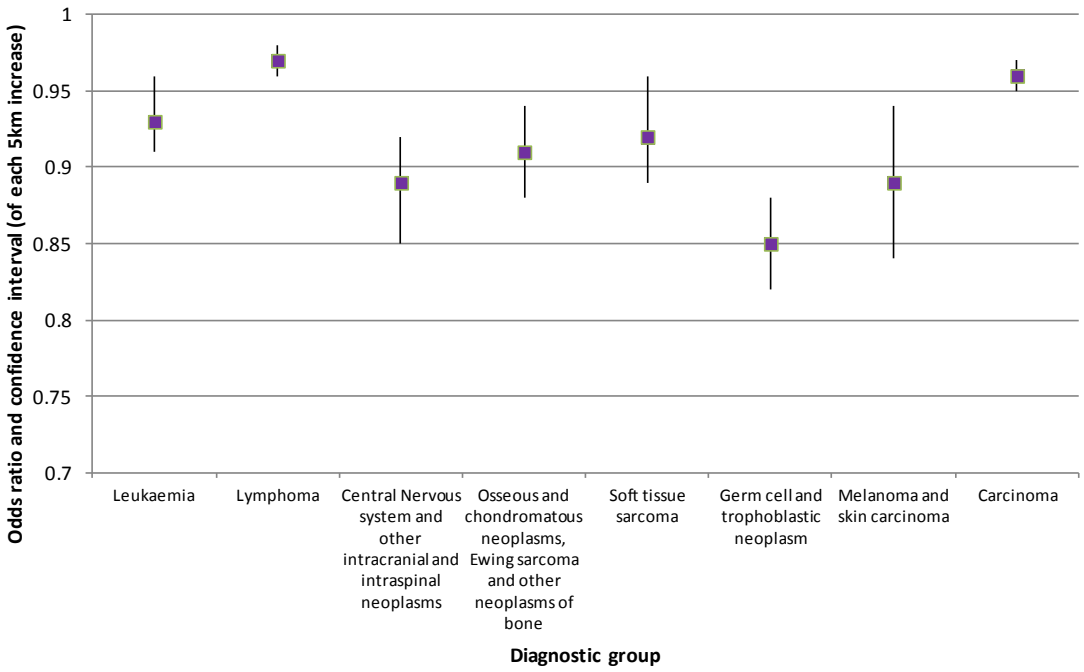
Chapter 14 Summary of findings

The following subsections summarise the key findings and then breaks down the results for each diagnostic group. The main findings are described here but are discussed in detail in Chapter 15 and Chapter 16.

14.1 Key findings

Distance between a patients home and their closest centre was a significant factor in the likelihood of admission to a TCT centre during treatment for all diagnostic groups, although the size of the effect varied between groups (Figure 104). A 5km increase in distance from the TCT centre had the greatest effect for patients diagnosed with germ cell tumours, decreasing the likelihood of admission by 15% (OR 0.85 95%CI 0.82-0.88). The smallest effect was seen in those diagnosed with lymphoma where each 5km increase reduced the likelihood of admission by 3% (OR 0.97 95%CI 0.96-0.98). The remaining diagnostic groups fell between these two extremes.

Figure 104: Odds ratios of admission to a TCT centre, by diagnostic group (showing 95% confidence intervals)



The proportion of patients from each diagnostic group who had one or more admission to a TCT centre during treatment also varied between diagnostic groups, ranging from 61.9% of bone tumour patients to 16.9% of melanoma patients (Figure 105). The proportion admitted to a site specialist centre also varied between diagnostic groups, although a greater proportion

of patients from each of the three groups were admitted once or more to a site specialist centre (Figure 106).

Figure 105: Proportion of patients admitted to a TCT centre during treatment, by diagnostic group

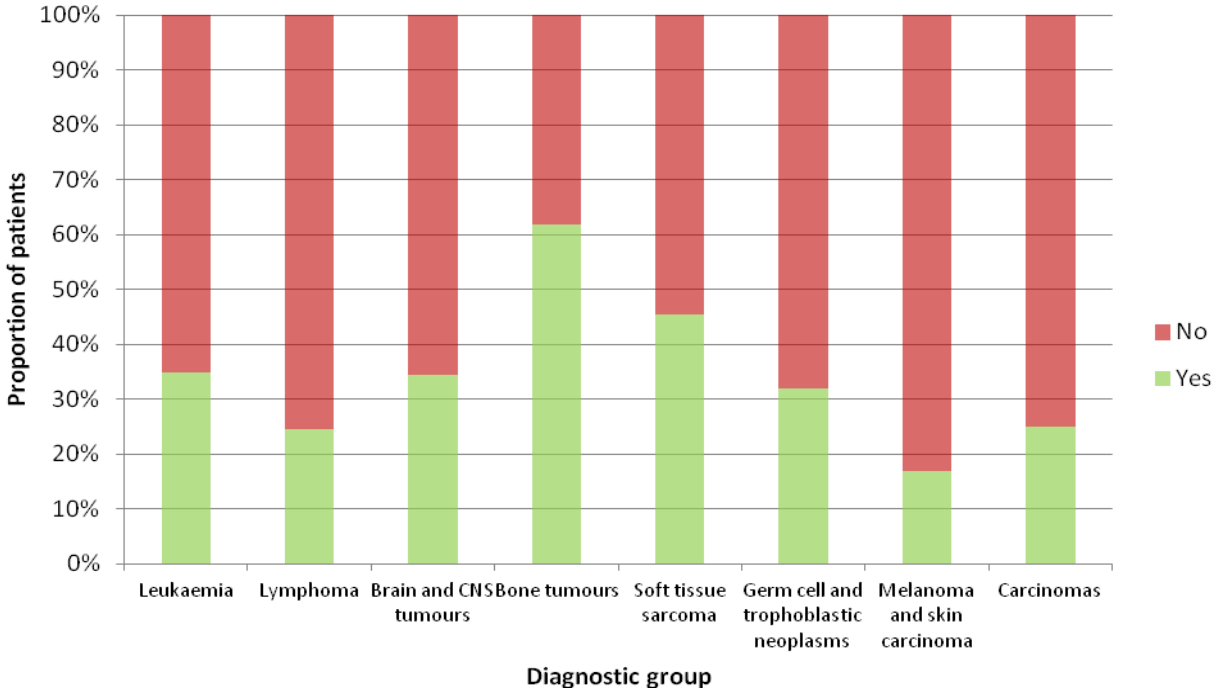
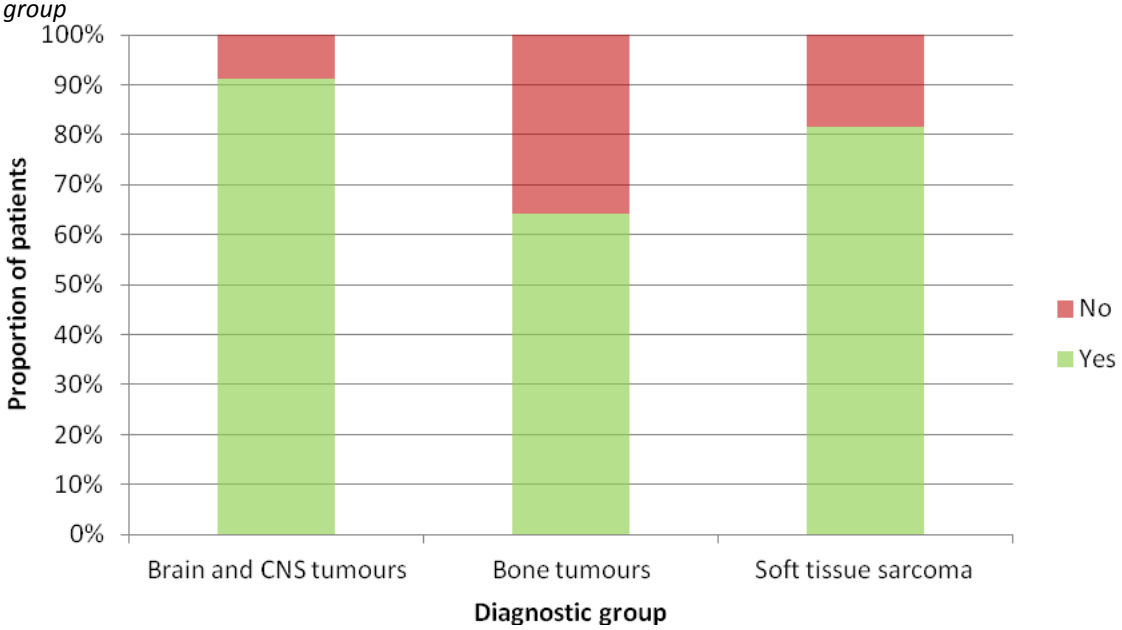


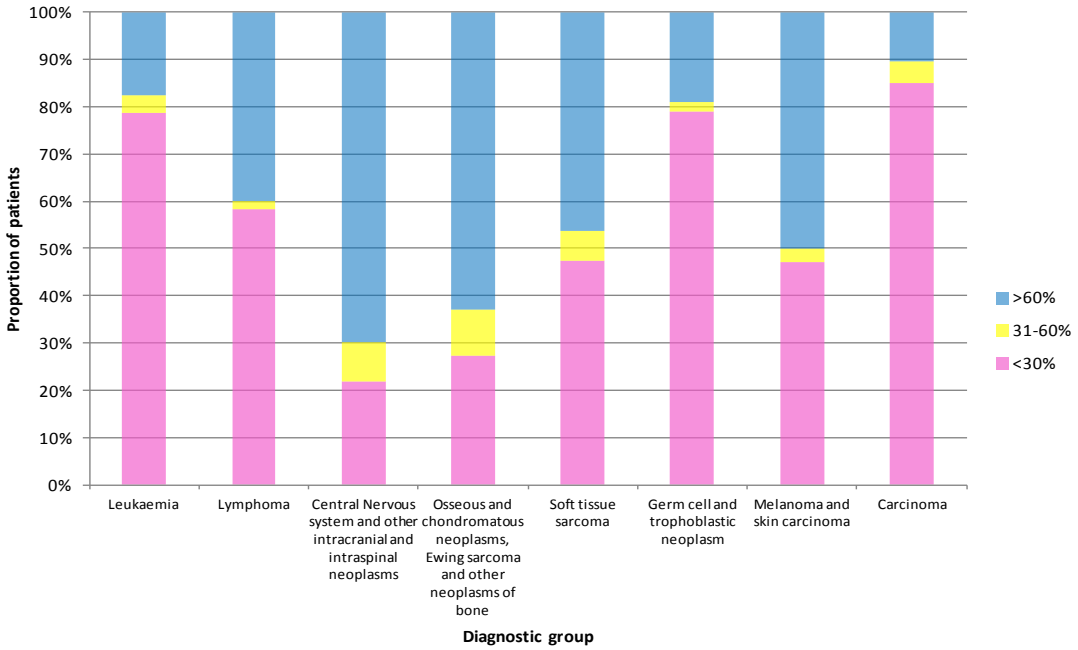
Figure 106: Proportion of patients admitted to a site specialist centre during treatment, by diagnostic group



The three diagnostic groups for which there were site specialist units (CNS, bone and STS) spent a greater proportion of time as inpatients in specialist centres. Overall 69.9% of brain and CNS patients spent more than 60% of their time as inpatients in specialist centres. This proportion was 63.0% of bone tumour patients and 46.2% of STS patients. This is in contrast to

the high proportion (94.3%) of melanoma patients who spent less than 30% of their time as an inpatient at a specialist centre. Similarly 85.1% of those with carcinomas spent less than 30% of time at a specialist centre, as did 79.0% of germ cell tumour patients (Figure 107).

Figure 107: Proportion of time spent at a specialist centre, by diagnostic group



The effect of specialist care on survival varied between groups. For leukaemia, lymphoma and brain tumours a greater proportion of time spent in a specialist centre appeared to reduce the risk of death. In contrast, STS, germ cell, melanoma and skin carcinoma, and carcinoma patients receiving the highest proportion of specialist care fared worse in terms of survival than those with limited input. Receiving some specialist care appeared to be related to a higher risk of death in the majority of diagnostic groups, the exceptions being non-Hodgkin's lymphoma and brain tumours, where it had a positive effect, although this was non-significant (Table 112).

The effect of the type of care was assessed for brain and bone tumours and STS. For patients diagnosed with a bone tumour age appropriate care, site specific care and a combination of the two had a protective effect on the risk of death, although this was only statistically significant in the case of site-specialist care, where it reduced the risk of death by 91% (HR 0.09 95%CI 0.02-0.39). Site specific care had a similarly beneficial effect on survival for patients diagnosed with an STS, although this was non-significant. Age-appropriate care for this group was associated with a non-significant increase in risk of death. Involvement of either age- or site- specific care alone was related to an increased risk of death for patients diagnosed with a

brain tumour, e.g. age-appropriate care alone increased the risk of death 2.4 fold (HR 2.41 95%CI 1.21-4.83) (Table 112).

Table 112: Cox regression results showing the effect of specialist care and patient demographics on survival, by diagnostic group

		Age at diagnosis		Gender			Year of diagnosis		Amount of specialist care					Type of specialist care						
				Male	Female				Limited	Some		Mostly		Limited	Site		Age		Site and age	
		Haz. Rat	p value		Haz. Rat	p value	Haz. Rat	p value		Haz. Rat	p value	Haz. Rat	p value		Haz. Rat	p value	Haz. Rat	p value	Haz. Rat	p value
Leukaemia		1.02	0.30	1.00	1.11	0.41	0.94	0.11	1.00	1.16	0.65	0.83	0.28							
Lymphoma	Non-Hodgkin's	1.08	0.04	1.00	0.77	0.18	0.90	0.06	1.00	0.28	0.21	0.38	<0.01							
	Hodgkin's	1.00	0.96	1.00	0.94	0.81	0.98	0.80	1.00	2.38	0.15	0.56	0.03							
Brain and CNS tumours		0.95	0.06	1.00	1.15	0.36	0.94	0.17	1.00	0.95	0.90	0.61	0.10	1.00	1.40	0.22	2.41	0.01	1.00	
Bone tumours		1.03	0.35	1.00	1.02	0.89	0.95	0.23	1.00	1.76	0.03	1.00		1.00	0.09	<0.01	0.81	0.27	0.73	0.19
Soft tissue sarcoma		1.08	0.03	1.00	0.56	<0.01	1.05	0.38	1.00	2.00	0.07	1.59	0.06	1.00	0.80	0.37	1.19	0.58	1.00	
Germ cell and trophoblastic neoplasms		1.02	0.76	1.00	0.69	0.48	1.05	0.56	1.00	2.92	0.16	4.83	<0.01							
Melanoma and skin carcinoma		0.97	0.57	1.00	0.17	<0.01	0.95	0.56	1.00			3.65	<0.01							
Carcinomas		1.05	0.06	1.00	0.44	<0.01	0.97	0.34	1.00	1.55	0.20	2.78	<0.01							

Key

	Significant survival benefit		Significant survival disbenefit
0.97	Non-significant benefit	1.43	Non-significant disbenefit

The following sections summarize the results for each diagnostic group in detail.

14.2 Leukaemia

14.2.1 Access to specialist care

Eight TCT units were able to admit TYA patients during the study period, whilst over half of these patients were not admitted to a TCT unit during the study period (Table 24). Distance from home address to the closest unit was a significant factor affecting the likelihood of a TCT admission (Table 25).

Admission to a TCT specialist centre varied by geography, with some units attracting patients from outside their catchment areas (Map 6 &Map 7), whilst others had large numbers of patients in their catchment area who were not admitted to a TCT centre during treatment (Table 24).

In the majority of cancer networks, most patients received limited specialist inpatient input during the treatment period. Four cancer networks, however, either contained or were in close proximity to a TCT centre at the time of the study (Table 26). Six out of the 16 trusts admitting the greatest number of patients had a TCT centre, which accounted for 75% of all TCT centres open at the time.

14.2.2 Specialist care uptake

In total 21.1% of patients received more than limited specialist inpatient input during their treatment, 3.5% received some specialist care and 17.6% had mostly specialist inpatient care. Overall 79.9% received limited specialist input, so that less than 30% of their total inpatient stay was spent in an NHS trust with a TCT centre (Table 29).

The distribution of age at diagnosis, diagnostic group and treatment received differed between the specialist care groups. More patients receiving limited specialist input were from the older age group (20-24). Acute lymphoblastic leukaemia was the most common diagnosis but this made up a larger proportion of all diagnoses in the group receiving some specialist input. The mainstay of treatment for patients with limited and mostly specialist care was chemotherapy, whilst for those with some specialist input it was chemoradiotherapy. All of these results demonstrate the case mix variations between the levels of care.

14.2.3 Patient outcomes

The highest proportion of patients with no treatment recorded was seen in those with limited specialist input (Figure 20).

Patients with a diagnosis of CML had the best three-year survival and those with AML had the poorest (Figure 21 & Table 32). Patients who received some specialist input had the poorest survival, whilst those with mostly specialist care had the best survival outcome (Figure 22 & Table 32). Those with some specialist input also had the highest health service usage during treatment, with the highest median number of admissions (Figure 24), the greatest proportion of unplanned admissions (Figure 25) and, on average, spent the largest proportion of the treatment period as an inpatient (Figure 26). This was reflected in the median cost of admissions during treatment, with those with some specialist input having the greatest total cost (Figure 27).

14.3 Lymphoma

14.3.1 Access to specialist care

Only 31.5% of lymphoma patients (596 patients) were admitted to a TCT unit at any point during their treatment (Table 33), so that over two-thirds received no admission to a TCT centre during treatment. Once again increasing distance between residential address and the closest TCT unit was a significant factor in reducing the likelihood of admission to a specialist centre (Table 34).

The proportion of patients admitted to a specialist centre varied by the geographical location of a patient's home, with units such as Southampton and University College London Hospitals having large numbers of patients for whom they were the closest who were not admitted to any TCT unit (Table 33). The catchment area of units also varied, with several attracting patients from a larger area than predicted, whilst some had a tighter distribution of patients (Map 8 & Map 9).

The majority of patients received limited specialist inpatient input in most cancer networks (Table 35). The majority of patients in eight networks received mostly specialist care, these networks either containing a TCT centre or having close links with one such unit at the time of admission. However this pattern was seen for several of the networks with limited specialist input suggesting that the presence of a TCT centre cannot be the sole explanatory factor.

Six out of the eight TCT centres were seen in the top 15 highest ranking trusts in terms of patient numbers (Table 36) and five were in the top 15 in terms of admissions (Table 37). Southampton admitted 2.3% of all lymphoma patients but did not have enough admissions to appear in the top 15 in terms of admissions. The remaining trusts in both lists were predominantly high volume cancer centres or large trusts which covered a wide geographic area.

14.3.2 Specialist care uptake

The demographics of the patients who received mostly specialist care were broadly similar to those who had limited specialist input. Those who had some specialist input were shown to be different (Table 38) from both other groups. These patients were predominantly from the younger age group (aged 15 to 19 at diagnosis) and were mostly female. Opposite patterns were seen in the other two specialist groups, where the majority of patients were older males, aged 20 to 24 at diagnosis.

14.3.3 Patient outcomes

The vast majority of patients were recorded as having had treatment of some description (Figure 29). Overall the patients who received mostly specialist care had the highest proportion with no recorded treatment, with 15.4% of all patients in this group having had no treatment recorded in either the HES or cancer registry data.

Survival for patients diagnosed with lymphoma varied between diagnostic group and level of specialist care received. Overall, patients with a diagnosis of non-Hodgkin's lymphoma had worse survival than those with Hodgkin's lymphoma (Figure 30). The variation in survival by specialist care level differed between the two diagnostic groups: for non-Hodgkin's lymphoma those with limited specialist input had the worst survival. Those receiving some and mostly specialist care had very similar survival curves (Figure 31). A different pattern was seen in patients with a Hodgkin's lymphoma, such that those with some specialist input have the poorest survival and those with mostly specialist care had the highest chances of survival (Figure 32). Increasing age at diagnosis had a statistically significant detrimental effect on survival. Increasing year of diagnosis and receiving mostly specialist care significantly decreased the risk of death.

Patients who received some specialist care had the highest number of admissions during treatment (Figure 34), the greatest proportion of unplanned admissions (Figure 35) and also spent the greatest proportion of the treatment period as an inpatient (Figure 36). This group also had the highest total cost for admissions during treatment (Figure 37), however those who received mostly specialist care had the highest median cost per admission (Figure 38).

14.4 Central nervous system and other intracranial and intraspinal neoplasms

14.4.1 Access to specialist care

In total 65.7% of brain and CNS tumour patients were not admitted to a TCT unit during treatment (Table 43), whilst in contrast only 8.7% had no admissions to a CNS specialist centre during treatment (Table 45).The number of patients admitted to specialist care varied by geography with some trusts admitting very few of the patients living closest to them and others attracting patients who lived closer to other centres.

All TCT centres attracted CNS patients from a much smaller area than the expected catchment area mapped for each trust (Map 10 & Map 11).

The distance from a patient's home address to the closest specialist centre significantly affected the likelihood of admission to both TCT and CNS centres. Each 5km increase in distance from a TCT centre decreased the likelihood of admission by 11% (Table 44), and each 5km increase in distance from a CNS centre decreased the likelihood of admission by 6% (Table 47).

In the majority of cancer networks most patients received mostly specialist care, whereas the majority of patients received limited specialist input in only four networks (Table 48). The specialist care received was predominantly CNS related, with only one network having the majority of those with mostly specialist care receiving care in a TCT centre (Table 49).

All but one NHS trust which ranked in the top 15 in terms of patient numbers contained a specialist centre of some form (Table 50). Trusts which were seen in the top 15 in terms of number of admissions which were neither CNS nor TCT centres were high volume cancer centres or large teaching hospital trusts.

14.4.2 Specialist care uptake

In contrast to the other levels of specialist care, the majority of patients who received limited specialist care were from the younger age group (aged 15 to 19 at diagnosis) (Table 52 & Table 53). In all groups with the exception of those receiving CNS & TCT specialist care, patients were predominantly male. A greater proportion of those with TCT input had been diagnosed with an astrocytoma. More patients who received CNS & TCT input were diagnosed with high grade tumours than in any other type of specialist care.

14.4.3 Patient outcomes

Those patients receiving limited specialist input had the greatest proportion with no treatment recorded (Figure 40 & Figure 41). Over half of all patients were recorded as having undergone surgery, with or without chemo-radiotherapy. This proportion was higher in patients who had received mostly specialist care or CNS specialist care, with or without TCT input.

Three year survival differed between diagnostic group, tumour grade, amount and type of specialist care received. Medulloblastoma and other PNET tumours had worse survival than any other diagnostic group (Figure 42). Patients with high grade tumours fared worse than those with low grade tumours (Figure 43). Those who received only limited specialist input had better survival than those with some or mostly specialist care, those with some specialist input had the worst survival, with less than 75% surviving to three years (Figure 44). Patients with TCT specialist input had the lowest survival, whilst patients with both CNS and TCT input had the best survival outcomes (Figure 45).

Receiving TCT specialist care alone was associated with a negative effect on survival. Increasing amount of specialist care had a beneficial effect on survival (Table 57), however this was not statistically significant.

Patients who received CNS or some specialist care had the highest number of admissions during treatment (Figure 48). Those with some specialist care also had the greatest proportion of unplanned admissions (Figure 49) and spent the largest proportion of the treatment period as an inpatient (Figure 50). Those receiving TCT specialist care spent the greatest proportion of the treatment period as an inpatient of any type of specialist care.

Those who received some specialist care and those with TCT specialist care had the highest median cost of admissions during treatment (Figure 51) and also had the highest median cost per admission (Figure 52).

14.5 Osseous and chondromatous neoplasms, Ewing's sarcoma and other neoplasms of bone

14.5.1 Access to specialist care

Overall 38% of patients were not admitted to a TCT unit during the treatment period. This proportion varied between centres, with all of those living closest to the centre in Newcastle being admitted to a TCT centre. This was in contrast to only 38% of those who lived closest to the centre in Southampton (Table 58).

The centres at UCL, Leeds, the Christie and Newcastle admitted patients from a larger area than predicted, suggesting that patients were travelling beyond their closest centre for admission. In contrast the centres at Southampton, Birmingham, Sheffield and Alder Hey attracted patients from a smaller area than expected (Map 12 & Map 13).

Every increase of 5km between a patient's home address and the closest centre was associated with a statistically significant decrease in the likelihood of admission to the centre (Table 59). Those diagnosed with 'other bone tumours' were less likely to be admitted to a TCT centre than those with osteosarcoma.

In total 64.2% of all bone tumour patients were admitted to a bone tumour centre at some point during treatment. The proportion of patients admitted varied between centres: the Freeman in Newcastle admitted 87% of patients for whom it was the closest centre. In contrast the Robert Jones and Agnes Hunt centre in Oswestry admitted only 49% of patients for whom it was the closest bone tumour diagnostic centre (Table 60). Most patients were admitted to bone tumour centres other than the one closest to their home address, for example patients closest to the centre in Newcastle travelled to the centre in Birmingham, patients from Oxford travelled to the centre at Stanmore and more patients who lived closest to the centre at Oswestry were admitted to Birmingham than Oswestry (Table 60).

Centres at Birmingham and Oswestry attracted patients from a wider than predicted geographical area, whilst the centres in Newcastle and Oxford had a smaller catchment area than predicted (Map 14 & Map 15).

As with admissions to a TCT centre, increasing distance from a bone tumour centre decreased the likelihood of admission to the centre. Both those diagnosed with Ewing's sarcoma and those with 'other bone tumours' were less likely to be admitted to a specialist bone tumour centre than those diagnosed with osteosarcoma (Table 61).

The majority of patients in 22 of the cancer networks received mostly specialist care, of these 16 received the majority of their care in a TCT specialist centre. One cancer network in England (Thames) had the majority of patients treated in a bone cancer specialist centre, for the remaining five networks patients were mainly treated in bone and TCT centres combined (Table 62 & Table 63).

Four of the five bone tumour specialist centres were seen in the top 15 high volume centres in terms of number of patients, the only exception being the Robert Jones and Agnes Hunt centre. In total 10 were specialist centres of some description (Table 64). Three of the five were in the top 15 in terms of number of admissions, both the Robert Jones and Agnes Hunt centre and the centre in Oxford fell outside this group (Table 65).

14.5.2 Specialist care uptake

Bone tumour patients were more likely to be male and aged 15 to 19, except for patients who received bone and TCT specialist care who were predominantly from the older age group (20 to 24) (Table 66 & Table 67).

Half of all patients who received mostly specialist care had been diagnosed with an osteosarcoma; this proportion was greater than that seen in any of the other levels of specialist care (Table 66). The same predominance of osteosarcoma was seen in patients with bone tumour specialist input, with or without TCT input (Table 67).

Those receiving some specialist input and those with TCT specialist care alone had the lowest proportion surviving to the end of the treatment period, whilst the highest proportion was seen in those with both bone and TCT specialist input (Table 67).

The majority of patients in all groups had undergone major surgical resection of their tumour, with or without chemo/radiotherapy (Table 66 & Table 67).

14.5.3 Patient outcomes

Over 70% of patients in all specialist care groups had undergone surgery with or without additional therapy (Figure 54 & Figure 55). Those with TCT specialist input had the highest proportion who received chemo/radiotherapy and the lowest proportion who received surgery (Figure 55). Patients in all groups were recorded as having received treatment of some form. The only group where patients had no treatment recorded was those with limited specialist care.

Patients diagnosed with ‘other bone tumours’ demonstrated the best three year survival and those with Ewing’s sarcoma had the worst, with 50% surviving to three years from diagnosis (Figure 56). The poorest survival was seen in those with some specialist input, the best was seen in those who received mostly specialist care (Figure 57). Treatment at a bone tumour specialist centre, without the involvement of a TCT centre, was associated with improved survival when compared with both limited specialist care and treatment at a TCT centre (Figure 58).

A diagnosis of ‘other bone tumour’ and treatment at a bone tumour specialist centre both had a statistically significant beneficial effect on survival (Table 71). Treatment at a TCT centre or at a combination of bone and TCT centres was also shown to reduce the risk of death, although this effect was not statistically significant. In contrast, receiving some specialist care had a statistically significant detrimental effect on survival.

There was little variation in the number of admissions during treatment by the amount of care received. However, those with bone tumour specialist care had fewer admissions than those with any other type of specialist care (Figure 61). In contrast those with bone tumour specialist care had a higher proportion of unplanned admissions than those with any other type of specialist care. Those with TCT input and mostly specialist care had the lowest levels of unplanned admissions (Figure 62). Despite the high levels of unplanned specialist admissions in those with bone tumour specialist input, they spent the smallest proportion of the treatment period in hospital, whilst those with bone and TCT input spent the greatest proportion of the treatment period as an inpatient (Figure 63).

Those with limited specialist input and those with bone tumour specialist care had the lowest total cost of admissions during the treatment period, whereas those with bone and TCT specialist input had the highest (Figure 64). The same cost pattern was seen when examining the average cost per admission by the amount of care received. The opposite effect was seen when assessing the costs by the type of care received. Those with bone tumour specialist care had the highest average cost per admission, whilst those with bone and TCT specialist care had the lowest average cost per admission (Figure 65).

14.6 Soft tissue sarcoma

14.6.1 Access to specialist care

In total 54.7% of those diagnosed with an STS were not admitted to a TCT centre during treatment. The proportion of patients who lived closest to each centre who were admitted ranged from 96% for those living closest to the TCT centre in Leeds to 26% for those living closest to the centre in Sheffield (Table 72). The centres at Alder Hey, Sheffield and the Christie attracted patients from outside the predicted area, inferring that they were travelling beyond their closest centre. The centres at Southampton, Birmingham and Leeds had smaller than predicted catchment areas (Map 16 & Map 17).

A diagnosis of rhabdomyosarcoma or unspecified STS and increasing age at diagnosis increased the likelihood of admission to a TCT centre. Increasing road travel distance decreased the likelihood of admission to the closest centre (Table 73).

In total 81.6% of STS patients were admitted to an STS specialist centre during treatment. The proportion of patients admitted to their closest centre varied between centres. The centre at Newcastle admitted 93.3% of the patients for whom it was the closest in contrast to the Royal National Orthopaedic Hospital at Stanmore which admitted 18.8% of those who lived closest to it (Table 74).

Increasing road travel time decreased the likelihood of admission to the closest STS centre. In contrast to the results seen for TCT centres, a diagnosis of unspecified STS also decreased the likelihood of STS admission. Rhabdomyosarcoma was associated with an increased likelihood of an admission to an STS centre (Table 75).

In 18 of 31 cancer networks the majority of patients received mostly specialist care; in three networks patients received some specialist care; in the remainder the majority of patients received limited specialist input (Table 76). In seven networks the majority of patients received STS and TCT specialist input. In eight, the majority of patients received STS specialist care and in four the majority received TCT specialist care (Table 77).

Nine of the top 15 trusts in terms of the number of patients were STS specialist centres, four were both STS and TCT centres, whilst two were TCT centres (Table 78). Two trusts which ranked in the top 15 in terms of admissions were neither STS nor TCT specialist centres (Table 79), two in the top 15 in terms of patient numbers were neither STS nor TCT specialist centres however these were not the same centres.

14.6.2 Specialist care uptake

Soft tissue sarcoma was predominantly diagnosed in older male patients (20-24) from more deprived groups (Table 80 & Table 81). A different pattern was seen in those receiving some specialist input, STS specialist care and those with TCT care where the patients were predominantly from the younger group (15-19). The most commonly diagnosed tumour type was “other specified STS”. Despite the relative rarity of the diagnosis itself, “unspecified” STS accounted for over 30% of diagnoses in those with TCT specialist input. Over 50% of all patients survived to the end of the treatment period, the exception being patients with TCT specialist input, with 48.5% surviving through to the end of treatment.

14.6.3 Patient outcomes

The majority of patients in all specialist groups underwent a major surgical resection of their tumour. Overall very few patients were recorded as having no treatment, the largest proportion of patients with no treatment were seen in those with limited specialist input (Figure 67 & Figure 68).

Close to 100% of those diagnosed with a fibrosarcoma were alive three years post diagnosis, whereas less than 35% of those with a rhabdomyosarcoma were alive at the same point from diagnosis (Figure 69). Receiving limited specialist care was associated with better survival than either mostly or some specialist care (Figure 70). When examining survival by the type of specialist care those with limited specialist input again had the best survival. Patients admitted

to a TCT centre alone had the worst survival, whilst those with STS involvement fell between these two ranges (Figure 71).

Increasing age at diagnosis and a diagnosis of rhabdomyosarcoma were associated with a statistically significant increased risk of death. Receiving some and mostly specialist care was also associated with an increased risk of death, however this was not statistically significant. Fibrosarcoma and being female were associated with a statistically significant decreased risk of death (Table 85).

Those with some specialist input and those with TCT specialist care had the highest number of admissions during treatment, those with limited input had the lowest (Figure 74). The same groups had the highest and lowest proportions of unplanned admissions (Figure 75). Those with some specialist input and TCT specialist care also spent the greatest proportion of the treatment period as inpatients (Figure 76).

The groups with the highest number of admissions and those which spent the greatest proportion of the treatment period in hospital also had the highest total cost of admissions during treatment (Figure 77), and they also had the highest average cost per admission (Figure 78).

14.7 Germ cell and trophoblastic neoplasms

14.7.1 Access to specialist care

In total 31.8% of those diagnosed with a germ cell tumour were admitted to a TCT centre during treatment. The range in the proportion of patients admitted to their closest centre varied between centres. 74% of those closest to the Leeds TCT centre were admitted to a TCT centre at some point during treatment, in contrast only 10% of those closest to the UCL centre were admitted to a TCT centre (Table 86). The Christie attracted patients from a larger geographical area than predicted, whereas the other centres had a smaller than predicted catchment area (Map 18 & Map 19). Increasing distance to a TCT centre significantly decreased the likelihood of admission whilst a diagnosis of a non-gonadal germ cell tumour increased the likelihood of admission (Table 87).

The majority of patients in four of the 31 cancer networks received mostly specialist care. These networks all contained a TCT centre at the time of the study, however networks in which the majority of patients received limited specialist care also contained a TCT centre (Table 88).

Seven of the eight TCT centres were seen in the top 15 centres in terms of both patients and number of admissions, whilst the other centres were high volume hospitals covering large geographical areas (Table 89 & Table 90).

14.7.2 Specialist care uptake

The germ cell tumour patients were predominantly aged 20 to 24 at diagnosis, male and had been diagnosed with a gonadal germ cell tumour. This profile differed between the specialist care groups. There was a higher proportion of younger (15-19) and female patients seen in those with some specialist care. This group also had a higher proportion of those from more deprived areas. Survival for the duration of treatment was high across all groups, ranging from 98.8% in those with limited specialist input to 89.6% in those with mostly specialist care.

14.7.3 Patient outcomes

The majority of germ cell tumour patients were treated with surgery and additional therapy. Very few patients were recorded as having no treatment, although this proportion was highest in those who had received some specialist input (Figure 80).

Patients diagnosed with a gonadal germ cell tumour fared better than those with a non-gonadal tumour with over 75% alive at three years from diagnosis (Figure 81). Limited specialist input was associated with the best survival whilst those who received mostly specialist care had the worst survival (Figure 82). A diagnosis of a non-gonadal germ cell tumour was associated with a statistically significant increased risk of death, as was receiving mostly specialist care (Table 94).

Patients who received some specialist care had the highest number of admissions during treatment (Figure 84), had the largest number of unplanned admissions (Figure 85) and spent the largest proportion of the treatment period as an inpatient (Figure 86). This group also had the highest median total cost of admissions during the treatment period (Figure 87), however the median cost per admission was the same across all groups (Figure 88).

14.8 Melanoma and skin carcinoma

14.8.1 Access to specialist care

In total 16.9% of patients diagnosed with a melanoma or skin carcinoma were admitted to a TCT centre during treatment. The number of patients admitted to their closest centre varied between TCT centres, for instance 1% of those living closest to the centre at UCL were admitted to a TCT centre. In contrast 40% of those living closest to the Christie were admitted to a TCT centre during treatment (Table 95).

The centre at Newcastle attracted patients from a larger geographical area than expected, whereas the remaining centres all had a smaller than expected catchment area (Map 20 & Map 21).

Increasing road travel distance was associated with a statistically significant decrease in the likelihood of admission to a TCT centre (Table 96). A diagnosis of skin carcinoma was associated with a decreased likelihood of TCT admission, however this was non-significant.

In all cancer networks the majority of patients received limited specialist care (Table 97). Five out of the eight TCT centres appeared in the top 15 trusts in terms of patient and admission numbers (Table 98 & Table 99).

14.8.2 Specialist care uptake

In both specialist care groups the patients were predominantly aged 20 to 24, female and diagnosed with a malignant melanoma. The proportion of patients diagnosed with a skin carcinoma was higher in the group that received limited specialist care. Although over 90% of patients in both specialist care groups survived to the end of the treatment period, this proportion was higher in those receiving limited specialist care (Table 100).

14.8.3 Patient outcomes

Approximately 50% of patients who had limited specialist care were recorded as having no treatment, whilst this proportion was lower in those with mostly specialist care (around 30%). The remaining patients were reported as having surgery with or without additional therapy (Figure 90).

Survival for both melanoma and skin carcinoma was approaching 100% at three years, however those diagnosed with malignant melanoma had slightly worse survival than those with skin carcinoma (Figure 91). Patients who received mostly specialist care had worse survival than those with limited specialist input (Figure 92). Female gender and a diagnosis of skin carcinoma were both shown to reduce the risk of death, whilst receiving mostly specialist care was associated with an increased risk of death (Table 102).

14.9 Carcinomas

14.9.1 Access to specialist care

In total 24.9% of patients diagnosed with a carcinoma were admitted to a TCT centre during treatment. The proportion of patients not admitted to a TCT centre during treatment varied between centres. 34% of those who lived closest to the centre at Leeds were not admitted to a TCT centre, whilst in contrast 93% of those who lived closest to the centre at UCL were not

admitted to a TCT centre during treatment (Table 104). All the units showed a smaller than predicted catchment area (Map 22 & Map 23).

Increasing distance from the place of residence to a TCT centre decreased the likelihood of admission to a TCT centre during treatment as did a diagnosis of a breast cancer. A diagnosis of carcinoma of other and ill-defined sites increased the odds of a TCT admission (Table 105).

In the Yorkshire and North Trent cancer networks the majority of patients received mostly specialist care, in the remainder of networks, the majority of patients received limited specialist care (Table 106). All TCT centres with the exception of Alder Hey were seen in the top 15 in terms of both patient and admission numbers (Table 107 & Table 108).

14.9.2 Specialist care uptake

The majority of patients were aged 20 to 24 at diagnosis. The vast majority were also female and from more deprived groups. The greatest variation in demographics across the specialist care groups was seen in the distribution of diagnoses, with thyroid carcinoma accounting for over half of all those who received some specialist care. This was also the most common diagnosis in the group receiving mostly specialist care, closely followed by carcinoma of the genito-urinary tract. This was also the most common diagnosis in those with limited specialist input (Table 109).

14.9.3 Patient outcomes

The largest proportion of patients recorded as having no treatment was seen in the group who received limited specialist care. Overall the majority of patients received surgery with or without additional treatment. The proportion of patients receiving chemo-radiotherapy without surgery was highest in the group who had mostly specialist care (Figure 95).

Patients diagnosed with thyroid carcinoma had the best survival, whilst those with carcinoma of the gastro-intestinal (GI) tract, or other carcinoma had the worst (Figure 96). Those with mostly specialist care had the lowest survival to three years, whereas those with limited or some input had similar survival (Figure 97).

Female gender, a diagnosis of thyroid carcinoma, head and neck carcinoma and decreasing deprivation were associated with a decreased risk of death. A diagnosis of carcinoma of the GI tract and receiving some or mostly specialist care were both associated with an increased risk of death (Table 111).

Patients who received mostly specialist care had the highest number of admissions during treatment (Figure 99). There was little variation between specialist groups in terms of the

proportion of unplanned admissions (Figure 100). Those with mostly specialist care spent the greatest proportion of the treatment period as an inpatient (Figure 101).

Patients with mostly specialist care had the highest total cost of admissions during treatment (Figure 102), however those with some specialist input had the highest average cost per admission and those with mostly specialist care had the lowest cost (Figure 103).

Chapter 15 Conclusions

This study covered a wide range of diagnoses in a diverse and unique population. It is a novel piece of health services research evaluating variation in specialist care and its effects on patient outcomes and hospital burden. A summary of the findings are described in the following chapter.

15.1 Attitudes towards specialist care

The survey undertaken assessed the attitudes of healthcare professionals to what constituted the optimal specialist care TYA cancer patients should receive. Attitudes varied and the factors of care identified by the professionals as being key to 'specialism' varied widely falling into three clusters (Figure 18). The survey determined that many of the aspects of care deemed as important in the TYA IOG were assigned low importance by those professionals delivering care.

There are a multitude of diagnoses, treatments, pathways and protocols for TYA cancer and evidence already exists demonstrating patterns of care vary[36]. But, prior to this study the extent of this variation was not well quantified and the proportion of TYA patients treated at TYA specialist units was not known. It was also not clear to what extent any differences were due to patient choice or to a lack of appropriate referral to specialist units. This project was intended to provide evidence to help clarify these questions

All the respondents to the survey were involved in the treatment of TYA patients but, by their responses, it was clear there were divergent attitudes towards what constitutes optimal care for this TYA group. This variation in attitudes may reflect the known variation in place of treatment for TYA and, at least partially, explain why there is variation in how and where many TYA patients are treated. The preference of the person referring the patient towards a type of specialist care, age, site or both, may increase the likelihood that a particular care setting would be used over other available services.

This survey adds to what was already known about the variation in referral to specialist services for TYA cancer patients. The results were used to identify areas of interest for the main part of the project which were then examined using the routine data available, such as the importance of place of care. It was also used as a benchmark against which variation in care could be measured. Additionally the degree of disagreement with protocols seen in the survey was assessed against the extent to which patients were treated in line with protocol.

15.2 Access to specialist care

The access to specialist care analyses undertaken in this project demonstrated more variation than was expected. Very few patients in any diagnostic group were admitted to a TCT unit other than their closest centre and TCT centres generally admitted patients from a smaller than predicted geographical area. This, and the fact that increasing road travel distance significantly decreased the likelihood of admission to a TCT centre, suggests that ease of access to specialist care is a key influence on its uptake. Unfortunately, however, the data available for this project meant that it wasn't possible to determine whether this was influenced by patient choice, or lack of referral.

In contrast, patients frequently travelled to a site-specific specialist centre other than their closest unit despite increasing road travel distance decreasing the likelihood of admission to a specialist centre. This was particularly striking in the case of bone tumours, which is likely to be due to the structure of services for this group[123]. Diagnosis and surgery for bone tumours is centralised and policy dictates it ought only to take place at one of five centres in England meaning that, unlike that seen with TCT centres, there is no alternative place of care for this patient group. Similar patterns were seen for both brain and STS patients. The findings of this study demonstrate that where centralisation has been implemented the policy is, for the most part, adhered to in practice. A far smaller proportion of bone tumour patients had no admission to a site- specialist centre than an age-appropriate centre. Where there is flexibility in the referral pathway the variation in place of care is significant and there appears to be less standardisation. Work undertaken examining the impact of specialist care on patient outcomes demonstrates that treatment at a specialised centre is, for some of the cancers, associated with improved outcomes. Patients were more likely to be admitted to a specialist centre the closer they lived to a unit. This finding was statistically significant for bone tumour patients, but overall very few patients diagnosed with a bone tumour were never admitted to a bone tumour centre. Where flexibility remained in the referral pathway a greater proportion of patients failed to be admitted to a specialist centre. It is important to acknowledge that whilst travel time significantly affects the likelihood of admission to a centre those with centralised services appeared to have a higher uptake of specialist care.

The presence or absence of a TCT or site-specialist centre in a cancer network did not seem to consistently influence the level of care that the majority of patients received. Cancer networks where the majority of patients received mainly specialist care contained a TCT centre or site specialist centre. However there were networks with functioning centres in which the majority of patients received limited specialist care. The simple existence of a TCT centre did not ensure that the majority of patients were admitted to a specialist centre. This supports the findings of

the survey in suggesting that the uptake of specialist care is influenced, at least partly, by clinician attitudes.

Seven of the eight TCT centres consistently appeared in the top 15 trusts in terms of the number of TYA patients admitted and the number of admissions during treatment. In the three tumour groups for which there were site-specialist centres the majority of the top 15 contained a specialist centre. Those trusts which were neither site- nor age-specialist centres were high volume trusts which covered large urban populations.

Geographical barriers seemed to have a greater effect with regards to admission to TCT centres, where there was an alternative place of care, often closer to a patient's home address. More work would be needed to determine to what extent this is affected by patients choosing to remain close to home and what information informs this decision, or whether it is associated with under referral.

15.3 Uptake of specialist care

One possible explanation for variation in outcomes and uptake between the groups could be due to case-mix rather than due to the influence of specialist care. In order to attempt to quantify the differences in case-mix between the specialist care groups the demographic profile of each was compared.

This demonstrated clear variation between those receiving different levels of care. In all diagnostic groups the characteristics of the patients who received limited specialist care differed from those who received mostly specialist care. Staging information was not routinely available in the routine NHS data on which this study is based. This meant that, with the exception of brain and CNS tumours, where the predicted grade of the tumour was calculated from the tumour morphology, it was possible to establish whether those who received mostly specialist care had more advanced disease which would explain their need for specialist care. Staging was unlikely to completely explain the survival difference between the groups. The effect in melanoma and skin carcinoma patients is likely to have been significant as the majority of patients admitted were likely to be later stage, metastatic disease[267 268]. Several other measures were used as a proxy for stage, such as number of admissions, length of stay and treatment received. Variation in these factors was assessed across the specialist care groups. For the most part those receiving some specialist care had the highest number of admissions and spent the greatest proportion of the treatment period as an inpatient, this result is difficult to interpret as it could be caused by later stage disease, equally it may be the result of suboptimal or ineffective care. For bone tumour and carcinoma patients, the only

diagnostic groups where this was not the case, receiving some specialist care was associated with an increased risk of death (significant in the case of bone tumours). The patient demographics and treatment received varied little between the two groups, certainly there was not enough variation to suggest a significant difference in stage mix between those receiving some specialist care and others.

15.4 Patient outcomes

The level of care associated with the poorest outcomes varied between diagnostic groups and may, in part, be explained by the variation in tumour grade and morphology. However, a proportion of this variation in outcome can be directly linked to the amount of specialist care received. It has been demonstrated in this study that some patients do not require specialist care in order to alter their hard outcomes (such as those with skin carcinoma). It has also been demonstrated that receiving some specialist care is detrimental in most diagnostic groups, suggesting that these patients are not receiving optimal care. Some of this effect may be due to the case mix of the populations and the stage of disease at diagnosis. An attempt was made to assess this by examining the patient demographics in the different specialist care groups and comparing them across diagnostic groups. Whilst it was possible to assess the variation in demographics such as age at diagnosis, gender and tumour biology other factors which may have influence outcomes, such as stage of disease were not available. In groups such as non-Hodgkin's lymphoma and brain tumours, where the biology of the disease and outcomes are intrinsically linked and treatments vary, case mix may have had a greater impact than in cases such as bone tumours where there were relatively few diagnostic sub groups. In order to address this in future work more detailed tumour information would be required, alongside information on stage at presentation and treatment received.

15.4.1 Treatment

The modality of curative treatment differed between the diagnostic groups and, due to limitations in data availability, it was not possible to determine the dose or type of chemotherapy or radiotherapy received by patients. Nonetheless, it was possible to establish which patients had undergone a potentially curative operation. Binary treatment variables were compared (surgery Y/N, chemotherapy Y/N and radiotherapy Y/N) and the proportion of patients receiving gold standard treatment was shown to vary at each level of care, across all specialist care groups. Patients with limited specialist care were consistently less likely to receive what would be considered potentially curative treatment than those with mostly specialist care. Patients from diagnostic groups for which there were site-specialist centres, who were admitted to a site-specialist centre with or without TCT admissions, had a

potentially curative group of treatments more frequently than those who attended TCT centres alone or who had limited specialist care. This suggests that those who receive limited specialist input, or lack site-specialist input may have different predicted outcomes from the initiation of treatment. Staging information and details of the treatment intent, MDT outcomes, could be used in future work to quantify this.

15.4.2 Survival

The level of specialist care received and the impact on survival differed between groups. Patients diagnosed with leukaemia and HL who received mostly specialist care had the best survival outcomes when compared to those receiving some, or limited specialist input. In both cases those with some specialist input had the worst outcomes. This suggests that clinical guidelines for patients from these diagnostic groups should recommend that they receive most of their care in specialist centres. Hodgkin's lymphoma differed from all other diagnostic groups in that patients with some specialist input had the best survival, whilst those with limited input had the worst.

In contrast patients diagnosed with a germ cell tumour, melanoma or skin carcinoma or other carcinoma who received mostly specialist care had the worst survival outcomes whilst those with limited input had the best. This could be due to those who received limited input having a lower grade tumour requiring less inpatient care which would be available in a less specialised setting. Future work using more detailed data, including staging is important in order to establish what influence this is having.

In all diagnostic groups for which there were site specialist centres (brain, bone and STS) those patients who received limited specialist care had the best outcomes; as for germ cell tumours, melanoma, skin carcinoma and other carcinomas this may be due to an increased likelihood of patients with less advanced disease being seen outside of specialist centres. However, patients with a brain or bone tumour or STS who received some specialist care had the worst outcomes. For this reason and due to the variation in patient demographics between the levels of care, patients who receive some specialist care ought to be receiving a higher proportion of their care in specialist centres. Those experiencing limited specialist care are likely to have different clinical needs so that they are more likely to be treated successfully away from the specialist setting.

Patients receiving site specialist care, irrespective of involvement of a TCT unit, had improved survival when compared to those who were admitted to a TCT centre alone. This is likely to be due to differences in disease between the groups, with those admitted to a TCT centre alone

potentially being more likely to receive chemo/radiotherapy as a result of presenting with more extensive disease.

15.4.3 Health service usage

Health service usage was assessed as an outcome which may vary according to the level of specialist care received. In all groups, except for bone tumours and carcinoma, those patients with some specialist care had the highest number of admissions, the greatest proportion of unplanned admissions and spent the largest proportion of the treatment period as an inpatient. In a large number of diagnostic groups they also had the poorest outcomes. This may mean that this group either had more advanced disease or suggest that this group are potentially not receiving the most effective care.

15.4.4 Health service costs

Increased total cost of admissions during treatment was associated with those patients who had a higher number of admissions, an increased proportion of admissions which were unplanned and a greater proportion of the treatment period seen as an inpatient. However those specialist care groups with the highest total cost did not necessarily have the highest average cost per admission, suggesting that the number of admissions was masking the effect of the higher cost and less frequent admissions.

Chapter 16 Discussion

This study is the first in the world to quantify specialist care for teenage and young adult patients across an entire nation. It is a novel piece of health services research which examined the variation in access to such care for those treated in NHS facilities between 2001 and 2009 and the impact on survival and hospital burden. The relationship between the level of specialist care received and patient outcomes had not previously been assessed in such a wide group of tumours in this age group.

The results from this address the aims which were set out in Chapter 1

Aim i – to produce a definition of specialist care for TYA

This study has successfully quantified the care received by TYA patients in England between 2001 and 2009. It was possible to examine the proportion of care received by patients in each diagnostic group and demonstrate that not all patients had the same level of care, it was also shown that this could not entirely be explained by the case mix of the population in each diagnostic group. It also cannot be explained by geographical barriers as a large proportion of patients for whom there was a site specific specialist centre were admitted there, whilst a substantial number of patients were not admitted to a TCT centre. This variation emphasises the need for more structured referral and treatment pathways for TYA patients to enable a standardisation of care. However before this could be undertaken work would be needed to determine the exact reasons for the variation which was quantified in this study.

Aim ii – to describe variation in care pathways nationally in England

This project aimed to describe the variation in care for TYA patients in England over the study period and has, for the most part, entirely succeeded in achieving this aim. For each diagnostic group it has been possible to quantify and describe the variation in the level of care received, place of care, treatment undergone and health service usage for patients. As with the previous aim this variation cannot entirely be explained by the case mix of the population as there was little clinically significant variation between the groups. Whilst it is important to remember that the results of this study are not implying causation it can be demonstrated that care was not equal across the country and that this may mean some patients are not receiving optimal care and that inequities exist. The description of the variation in care pathways has been completed, meaning that work can now be undertaken to address this variation where possible.

Aim iii – to determine the effect of the level of specialist care received on survival and health service usage, during treatment

After describing the variation present, this project then attempted to determine the effect of this variation and the level of care received on patient outcomes. In all diagnostic groups survival varied according to the level of care received, as did health service usage and the cost of admissions during treatment. The major outcome from this work was that it was possible to demonstrate not only that the level of care received by patients varied across the country but also that survival appeared to be influenced by the amount and type of specialist care received. These survival differences, in combination with the variation in care, further emphasise the need for standardisation of care to enable a greater proportion of patients to receive the optimal care pathway for their diagnostic group. This is the first study to quantify this effect in TYA cancer patients.

This study showed that the amount of specialist care received by each patient varied both between and within diagnostic groups. The centralisation of services, such as that for bone tumours, positively influenced the likelihood of admission to a specialist centre. This is thought to be due to the rigid referral guidelines in place for these services. Travel distance between home and the closest centre affected the likelihood of admission, supporting the case for more TCT centres, or a greater number of shared care centres allowing greater access for the TYA cancer population as a whole. The level of specialist care received influenced survival and health service usage in all groups. Groups of patients were identified, such as those with skin carcinoma, for whom specialist care appeared to have little effect. However for the most part those who received some specialist care had the poorest outcomes, suggesting that these patients ought to have received mostly specialist care. This contrasts with those who received limited specialist care who seemed to display different characteristics to those in the other group and, for the most part, appeared to receive limited benefit from specialist input. This suggests that, for this group, specialist care was not required, emphasising the need to target specialist care appropriately, rather than assuming that all patients require the same level of care. Or indeed that failure to receive age specialist care was detrimental in all cases.

As shown in the literature review and background (Chapter 2), the evidence base supporting treatment in specialist centres for TYA patients in the UK and elsewhere around the world is relatively weak. The findings from this work provide, therefore, important information on the delivery of care among 15-24 year olds and can act as a benchmark for the NHS.

The data available to perform this work, whilst being of high quality in some areas, also had some well recognised weaknesses, such as incomplete staging and treatment data and lack of outpatient information. Certain methodologies had to be adapted to address these issues

where possible. The unique nature of this study also meant that there were few other high quality, population-based studies to compare the results to.

The strengths and limitations of this study are discussed in this chapter, as are the key findings from the study and their implications for service development and structure. Finally, the additional questions raised by this study and future areas of research will be considered and discussed in the future.

16.1 Strengths of the study

This was a high quality population based study which utilised national data and had full coverage of England meaning that the study had the greatest possible statistical power. The data were cleaned using a novel algorithm designed specifically for use on cancer registration data regarding TYA patients, allowing for the production of the most accurate dataset possible. The cancer registration data were linked to HES data using validated methodologies[240]. Methodologies were adapted to fit the data available and the questions posed.

16.2 Limitations of the study

Certain limitations of the study mean that some of the results should be interpreted with a degree of caution. Limitations relate to issues around data quality, study design and certain aspects of the analysis.

16.2.1 Data quality

The design of the survey meant that there was likely to be bias in the sample selection, however this was unavoidable due to the nature of the data. The nature of the purposive sampling approach meant that generalisations across all healthcare professionals dealing with TYA patients are difficult to make. Nonetheless, this was the first survey of its kind to address attitudes towards specialist care for this group and there was little available evidence in which to compare the results.

One of the most significant issues relating to this project was the quality of the available data. This project relied mainly upon routine healthcare data comprising cancer registration and electronically linked hospital admission records.

There are acknowledged limitations with cancer registration and HES data. Firstly, the cancer registration records for a small proportion of individuals were not linked to a HES record. This may have been due to a lack of admissions for these patients, because these patients were not treated as an inpatient at any time. Alternatively this may have been caused by issues with the

patient identifiers, so that patients may have been admitted to secondary care but this was not identified from the data linkage. In order to avoid drawing any incorrect conclusions, these patients were excluded from the analyses presented in this thesis. The numbers excluded for each diagnostic group were small (range 3.6% to 31.6% for melanoma) and did not present a significant problem.

Staging data were unavailable for 99% of cases, therefore it was not possible to use methods such as multiple imputation to overcome these missing data. Stage of disease is an important prognostic factor when assessing the case mix variation between specialist care groups. Although it wasn't possible to adjust for stage, several other proxy variables were identified, such as length of stay, number of admissions and diagnostic group. These would not correlate perfectly with stage of disease but allowed an attempt at identifying patient groups which may have presented with more advanced disease.

The HES data used in this study included only inpatient and day case episodes, thus it wasn't possible to examine outpatient or A&E attendances. The majority of TYA patients with cancer would, as a minimum, be expected to have a day case admission during treatment, so that it was possible to draw conclusions regarding health service usage across the diagnostic groups. Standardised treatment pathways ought to imply that within diagnostic groups there should be little variation in the care setting, in terms of in or outpatient care, limiting the effect on this study. This was not the case for melanoma and skin carcinoma patients, where the majority of treatment is undertaken either in primary care or as an outpatient. Patients who were admitted frequently were undergoing different treatment from those with less frequent admissions and so the results for this group have been cautiously interpreted.

A further limitation was the lack of detailed treatment information available. Surgery is well coded in HES data due to payment by results, however chemotherapy and radiotherapy coding is known to be variable. A combined treatment variable was produced to overcome this problem using a combination of HES and registry data. However, it was not possible to determine the dose or regimen patients received. HES data is also unlikely to give a complete picture of usage due to both coding issues and treatment undertaken in an outpatient setting . This problem is likely to be resolved in the future through developments in national cancer registration which will receive electronic data feeds from chemotherapy and radiotherapy episodes, supplementing the hospital episodes data already available[269 270].

There are several known issues with the data recorded in HES, such as incorrect admission and discharge dates and improper coding of place of care. The admission start and end dates were therefore recalculated and ought not to have affected the results of the study. To avoid

problems with the coding of place of care, the NHS trust to which a patient was admitted was used instead of the individual hospital site. This meant that it was impossible to infer whether a patient had been admitted to a specialist centre, although it was possible to specify whether the NHS trust to which a patient was admitted had a specialist centre. A necessary assumption was therefore made with regards to the involvement of specialists in the care of a patient based on where they were treated. This may have influenced the classification of level of care received by each patient. The comparison of time spent in a trust within a specialist centre to that spent elsewhere was used to assign each patient to a level of care. However the structure of specialist services means that admission to an NHS trust with a specialist centre would automatically result in the involvement of a specialist MDT, even if the patient was not admitted to the specialist ward itself. This means that the results regarding the level of care received can be relied upon.

16.2.2 Study design and data analysis

A major strength of this study is that it is the first of its kind in the area of TYA specialist care and applies recognised methodologies such as the linkage of multiple routine data sources Another strength is the number of cases used in comparison to other studies, particularly as TYA cancer is rare. This is one of the largest health services research studies in the area covering the whole of England over a diagnosis period of six years and treatment period up to the end of 2009.

The problems related to power in this study were unavoidable as, despite the small numbers, the results refer to a national analysis and several steps were taken in order to reduce the effect of the small sample size, such as the analysis of groups of diagnoses rather than individual morphological groups. A number of the effects seen, such as the beneficial effect of mostly specialist care in some groups failed to reach statistical significance, despite their clinical plausibility. The small number of patients means that there was, in some cases, limited power in the analyses influencing the significance of the results.

It was not possible to assess the levels of specialist care and type of specialist care in one analysis, they were assessed as separate variables due to the small number of patients in some of the groups. The analyses of these as separate variables allowed more detailed investigations.

The small number of events (deaths) for certain diagnostic groups may have led to a lack of power and under-reporting of some effects which were important clinically but may not have been statistically significant. All Cox regression models adhered to the proportional hazards assumption and were carefully tested for possible interactions and multicollinearity.

Multiple testing may also have led to the reporting of erroneous significant findings due to the number of comparisons carried out. Nonetheless, the research questions were carefully formulated at the beginning of the study. These were listed explicitly in Chapter 1 to minimise the over-reporting of significant findings through chance alone.

16.2.3 Interpretation

Mindful of these limitations, interpretation of the results should be done with some degree of caution.

The assignment of patients to a level of care was based on the proportion of time spent in specialist centres compared to other places of care. Caution should be used when interpreting the results in terms of distinct proportions of specialist care as these relied upon such components of care derived from HES data, which refer to inpatient and day case admissions only. No conclusions could be drawn in terms of outpatient admissions or health service usage in its entirety.

Missing data may also have influenced some of the conclusions drawn, in particular with regards to treatment. Missing staging information meant it was not possible to adjust for more advanced disease, this adjustment would have allowed more accurate inferences. Additionally the lack of HES data for some cases reduced the power of the analyses as these patients had to be excluded.

16.2.4 Strengths and weaknesses in relation to other studies

A major advantage of this study is that it is population based, whereas previous studies have tended to focus on a single region or centre. Also this study examined all diagnoses in TYA patients, the majority of studies examine a single cancer site, which appears counterintuitive as the service is designed for the age group as a whole.

It is the first to assess the influence of specialist care on outcomes comprehensively in this patient group. Other studies investigating specialist care for TYA patients have tended to focus on patient experience, psychosocial impact and place of care. Many of the findings of this research support results from other studies[37 129 271 272].

This study has shown, in agreement with others[36 114 192], that there is significant variation in the place of care for TYA patients. This was the first study to assess both age-specific and site-specialist care and report analyses which combined these two components to assess the impact on clinical outcomes. Additionally, this study assessed the influence of access to specialist care on the likelihood of admission to a specialist centre and also examined

admissions centre by centre. This is the first study to combine these analyses across all diagnoses in this age range.

A key finding was that specialist care influenced survival across all diagnostic groups. This supported the findings of several other studies[35 119 273 274], however these focus on much older adult patients. The inclusion of multiple patient outcomes sets this work apart from other studies which focus on survival as the main outcome.

16.3 Implications for teenage and young adult cancer care

Admission to a TCT or site-specialist centre was shown to influence outcomes in all diagnostic groups. The involvement of a site-specialist centre was uniformly associated with a survival benefit and the increase in centralisation of services to these centres means that referral to these services was seen in the majority of cases. However, this was not the case for the TCT centres and there appeared to be significant barriers to referral into these units. Whilst findings from this work support the value and use of specialist services, it also highlights the disparity between diagnostic groups in terms of the proportion of patients who received specialist care.

The results from this study, in particular the influence of the levels of specialist care on patient outcomes, will be used to inform analyses in a cohort study known as BRIGHTLIGHT[275] led by an experienced multi-disciplinary research team from the University College London Hospitals, University of Manchester and University of Leeds to examine the influence of specialist care on the quality of life for TYA patients. The methodology used to assign a type and level of specialist care in this analysis will be applied to the BRIGHTLIGHT cohort and results used to inform the future organisation of cancer services for this age group.

The work presented in this thesis encompasses a time period which includes the introduction of the IOG in 2005. Changes in the cancer registration process[276] will facilitate more detailed and timely treatment information to be made available for analysis. Nonetheless, this study can be used to benchmark improvement in patient outcomes and specialist service usage over time from 2001 onwards.

16.4 Unanswered questions and future work

Future work, including more timely data, would allow for an assessment of patient outcomes after the IOG had been fully implemented. It would also be possible to include staging and treatment information in the analysis, rather than using proxies in an attempt to assess the influence of these on outcomes and therefore provide a more accurate assessment of the

effect of specialist care. As previously stated efforts were made to determine whether stage of disease was at least partly responsible for the outcome differences between those with some specialist care and other groups, new systems in place for cancer registration ought to increase the proportion of cases with a reported stage. This would allow a more in-depth analysis of the relationship between stage, specialist care and outcome.

This project quantified the variation in uptake of specialist care across England but there remains the question as to why this occurs. Further work is needed to determine whether this is due to patient choice or limitations in the way services operate for young people with cancer which may result in lack of referral to specialist centres.

Also further studies may examine the influence of specialist care on late effects. This was not possible in this project due to the relatively short follow up period included in the analysis. However the results of such work will be vital for future service design regarding long term follow up of TYA cancer patients, especially whether certain patients are managed more effectively in primary or secondary care .

Bibliography

1. Cancer Research UK. All cancers combined Key Facts, 2012.

2. Cancer Research UK. Cancer mortality for all cancers combined, 2012.

3. Office for National Statistics. Deaths registered in England and Wales in 2010, by cause, 2011.

4. Birch JM, Pang D, Alston RD, Rowan S, Geraci M, Moran A, et al. Survival from cancer in teenagers and young adults in England, 1979-2003. *Br J Cancer* 2008;99(5):830-35.

5. The Expert Advisory Group on Cancer to the Chief Medical Officers of England and Wales. A policy framework for commissioning cancer services: A report by the Expert Advisory Group on Cancer to the Chief Medical Officers of England and Wales, 1995:32.

6. Department of Health. The NHS Cancer plan: a plan for investment, a plan for reform, 2000:97.

7. Department of Health. Cancer Reform Strategy, 2007:144.

8. National Institute for Health and Clinical Excellence. Improving outcomes in children and young people with cancer, 2005:198.

9. Cancer Research UK. Cancer incidence by age, 2012.

10. Bleyer A, O'Leary M, Barr R, Ries L, editors. *Cancer Epidemiology in Older Adolescents and Young Adults 15 to 29 Years of Age, Including SEER Incidence and Survival: 1975-2000.* Bethesda, 2006.

11. Bleyer A. Young Adult Oncology: The Patients and Their Survival Challenges. *CA: A Cancer Journal for Clinicians* 2007;57(4):242-55.

12. Bleyer A, Budd T, Montello M. Adolescents and young adults with cancer. *Cancer* 2006;107(S7):1645-55.

13. Geraci M, Birch JM, Alston RD, Moran A, Eden TOB. Cancer mortality in 13 to 29-year-olds in England and Wales, 1981-2005. *Br J Cancer* 2007;97(11):1588-94.

14. Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics. *CA: A Cancer Journal for Clinicians* 2011;61(2):69-90.

15. Jemal A, Center MM, DeSantis C, Ward EM. Global Patterns of Cancer Incidence and Mortality Rates and Trends. *Cancer Epidemiology Biomarkers & Prevention* 2010;19(8):1893-907.

16. Peto R, Boreham J, Clarke M, Davies C, Beral V. UK and USA breast cancer deaths down 25% in year 2000 at ages 20?69 years. *The Lancet* 2000;355(9217):1822.

17. Gatta G, Capocaccia R, Stiller C, Kaatsch P, Berrino F, Terenziani M, et al. Childhood Cancer Survival Trends in Europe: A EUROCARE Working Group Study. *Journal of Clinical Oncology* 2005;23(16):3742-51.

18. Berrino F, De Angelis R, Sant M, Rosso S, Lasota MB, Coebergh JW, et al. Survival for eight major cancers and all cancers combined for European adults diagnosed in 1995–99: results of the EUROCARE-4 study. *The Lancet Oncology* 2007;8(9):773-83.

19. Coleman MP, Forman D, Bryant H, Butler J, Rachet B, Maringe C, et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden, and the UK, 1995–2007 (the International Cancer Benchmarking Partnership): an analysis of population-based cancer registry data. *The Lancet* 2011;377(9760):127-38.

20. Eyre R, Feltbower RG, Mubwandarikwa E, Jenkinson HC, Parkes S, Birch JM, et al. Incidence and survival of childhood bone cancer in northern England and the West Midlands, 1981-2002. *Br J Cancer* 2009;100(1):188-93.

21. Department of Health Clinical Outcomes Group. Guidance on commissioning cancer services: improving outcomes in lung cancer the manual, 1998:73.

22. National Institute for Health and Clinical Excellence. Improving Outcomes in Colorectal Cancers, 2004:136.

23. Alston RD, Geraci M, Eden TOB, Moran A, Rowan S, Birch JM. Changes in cancer incidence in teenagers and young adults (ages 13 to 24 years) in England 1979–2003. *Cancer* 2008;113(10):2807-15.

24. Geraci M, Eden TOB, Alston RD, Moran A, Arora RS, Birch JM. Geographical and temporal distribution of cancer survival in teenagers and young adults in England. *Br J Cancer* 2009;101(11):1939-45.

25. Morgan S, Davies S, Palmer S, Plaster M. Sex, Drugs, and Rock 'n' Roll: Caring for Adolescents and Young Adults With Cancer. *Journal of Clinical Oncology* 2010;28(32):4825-30.

26. Stinson JN, Sung L, Gupta A, White ME, Jibb LA, Dettmer E, et al. Disease self-management needs of adolescents with cancer: perspectives of adolescents with cancer and their parents and healthcare providers. *J Cancer Surviv* 2012;6(3):278-86.

27. Zebrack B. Information and service needs for young adult cancer survivors. *Support Care Cancer* 2009;17(4):349-57.

28. Zebrack BJ, Block R, Hayes-Lattin B, Embry L, Aguilar C, Meeske KA, et al. Psychosocial service use and unmet need among recently diagnosed adolescent and young adult cancer patients. *Cancer* 2012:n/a-n/a.

29. Teenage Cancer Trust. Teenage Cancer Trust - A charity devoted to improving the lives of teenagers and young adults with cancer, 2012.

30. Begg CB, Cramer LD, Hoskins WJ, Brennan MF. Impact of hospital volume on operative mortality for major cancer surgery. *JAMA: the journal of the American Medical Association* 1998;280(20):1747-51.

31. Silvestri GA, Handy J, Lackland D, Corley E, Reed CE. Specialists achieve better outcomes than generalists for lung cancer surgery. *CHEST Journal* 1998;114(3):675-80.

32. Selby P, Gillis C, Haward R. Benefits from specialised cancer care. *The Lancet* 1996;348(9023):313-18.

33. Howell DL, Ward KC, Austin HD, Young JL, Woods WG. Access to pediatric cancer care by age, race, and diagnosis, and outcomes of cancer treatment in pediatric and adolescent patients in the state of Georgia. *Journal of Clinical Oncology* 2007;25(29):4610-15.

34. Gillis CR, Hole DJ. Survival outcome of care by specialist surgeons in breast cancer: a study of 3786 patients in the west of Scotland. *Bmj* 1996;312(7024):145-48.

35. Kingsmore D, Hole D, Gillis C. Why does specialist treatment of breast cancer improve survival? The role of surgical management. *Br J Cancer* 2004;90(10):1920-25.

36. Whelan J, Dolbear C, Mak V, Moller H, Davies E. Where do teenagers and young adults recieve treatment for cancer? *Journal of Public Health* 2007;29(2):178-82.

37. Hollis R, Morgan S. The adolescent with cancer — at the edge of no-man's land. *The Lancet Oncology* 2001;2(1):43-48.

38. Albritton KH, Eden T. Access to care. *Pediatric Blood & Cancer* 2008;50(S5):1094-98.

39. Whelan J. Where should teenagers with cancer be treated? *European Journal of Cancer* 2003;39:2573-78.

40. Zebrack B, Mathews-Bradshaw B, Siegel S. Quality cancer care for adolescents and young adults: a position statement. *Journal of Clinical Oncology* 2010;28(32):4862-67.

41. Grinyer A. The biographical impact of teenage and adolescent cancer. *Chronic illness* 2007;3(4):265-77.

42. Pearce MS, Parker L, Windebank KP, Cotterill SJ, Craft AW. Cancer in Adolescents and Young Adults Aged 15- 24 Years: A Report From the North of England Young Person's Malignant Disease Registry, UK. *Pediatric Blood and Cancer* 2005;45:687-93.

43. Arbuckle J, Cotton R, Eden T, Jones R, Leonard R. Who should care for young people with cancer? *Cancer and the Adolescent, Second Edition* 2005:229-40.

44. Bleyer A. Cancer In Older Adolescents and Young Adults: Epidemiology, Diagnosis, Treatment, Survival and Importance of Clinical Trials. *Medical and Pediatric Oncology* 2002;38:1-10.

45. Bleyer A, Budd T, Montello M. Adolescents and Young Adults with Cancer. *Cancer* 2006;107(7):1645-55.

46. Albritton K, Bleyer WA. The management of cancer in the older adolescent. *European Journal of Cancer* 2003;39(18):2584-99.

47. Lewis IJ. Cancer in adolescence. *British Medical Bulletin* 1996;52(4):887-97.

48. DOH. Improving Outcomes in Children and Young People with Cancer Guidance on Commissioning Services for Young People - Gateway reference 10393. In: Richards M, editor, 2008:14.

49. Fern L, Davies S, Eden T, Feltbower RG, Grant R, Hawkins M, et al. Rates of inclusion of teenagers and young adults in England into National Cancer Research Network clinical trials: Report from the National Cancer Institute (NCRI) Teenage and Young Adult Clinical Studies Development Group. *British Journal of Cancer* 2008;99:1967-74.

50. AYA PRG. Closing the Gap: Research and Care Imperatives for Adolescents and Young Adults with Cancer: U.S Department of Health and Human Services, NIH &NCI, 2006.

51. Birch JM, Pang D, Alston RD, Rowan S, Geraci M, Moran A, et al. Survival from cancer in teenagers and young adults in England, 1979-2003. *British Journal of Cancer* 2008:1-6.

52. Bleyer A. The adolescent and young adult gap in cancer care and outcome. *Current problems in paediatric and adolescent health care* 2005:182-217.

53. Desandes E. Survival from adolescent cancer. *Cancer Treatment Reviews* 2007;33(7):609-15.

54. Ellison LF, Pogany L, Mery LS. Childhood and adolescent cancer survival: a period analysis of data from the Canadian Cancer Registry. *European Journal of Cancer* 2007;43:1967-75.

55. Gatta G, Capocaccia R, De Angelis R, Stiller C, Coebergh JW. Cancer survival in European adolescents and young adults. *European Journal of Cancer* 2003;39(18):2600-10.

56. Gatta G, Zigon G, Capocaccia R, Coebergh JWW, Desandes E, Kaatsch P, et al. Survival of European children and young adults diagnosed 1995-2002. 2008.

57. Health Do. Improving Outcomes in Children and Young People with Cancer Guidance on Commissioning Services for Young People - Gateway reference 10393. In: Richards M, editor, 2008:14.

58. Kelly D, Gibson F, editors. *Cancer Care for Adolescents and Young Adults*. 1st ed. Oxford: Blackwell Publishing, 2008.

59. Kelly D, Mullhall A, Pearce S. Adolescent cancer- the need to evaluate current service provision in the UK. *European Journal of Oncology Nursing* 2003;7(1):53-58.

60. Linabery AM, Ross JA. Childhood and Adolescent Cancer Survival in the US by Race and Ethnicity for the Diagostic period 1975-1999. *Cancer* 2008;113(9):2575-96.

61. Lowis S. Malignant disease and the adolescent. *Journal of the Royal College of Physicians of London* 2000;34(1):27-31.

62. Schmidt C. Lack of progress in teen and young adult cancers concerns researchers, prompts study. *Journal of the National Cancer Institute* 2006;98(24):1760-63.

63. Kmietowicz Z. Prognosis for teenagers and young people with cancer fails to improve. *British Medical Journal* 2004;328:540.

64. Eden TOB, Barr RD, Bleyer A, Whiteson M, editors. *Cancer and the Adolescent*. 2nd ed. Oxford: Blackwell Publishing Ltd, 2005.

65. Jeha S. Who should be treating adolescents and young adults with acute lymphoblastic leukaemia? *European Journal of Cancer* 2003;39:2579-83.

66. Michie CO. Treating patients with cancer: individualising therapy, improving outcome. *Journal of the Royal College of Physicians of Edinburgh* 2008;38:251-55.

67. Newburger PE, Elfenbein DS, Boxer LA. Adolesents with cancer: access to clinical trials and age-appropriate care. *Current opinions in Paediatrics* 2002;14:1-4.

68. Allemani C, Sant M, De Angelis R, Marcos-Gragera R, Coebergh JWW, EUROCARE. Hodgkin Disease Survival in Europe and the US. *Cancer* 2006;107(2):352-60.

69. Ramanujachar R, Richards S, Hann I, Webb D. Adolescents with acute lymphoblastic leukaemia: Emerging from the shadow of paediatric and adult treatment protocols. *Pediatric Blood & Cancer* 2006;47(6):748-56.

70. Wu X-C, Chen VW, Steele B, Roffers S, Klotz JB, Correa CN, et al. Cancer Incidence in Adolescents and Young Adults in the United States, 1992-1997. *Journal of Adolescent Health* 2003;32:405-15.

71. Stiller C. International patterns of cancer incidence in adolescents. *Cancer Treatment Reviews* 2007;33:631-45.

72. Bleyer A, Barr RD, Hayes-Lattin B, Thomas DM, Ellis C, Anderson B. The distinctive biology pf cancer in adolescents and young adults. *Nature* 2008;8:288-98.

73. Bleyer A, Viny A, Barr RD. Cancer in 15 to 29 year olds by primary site. *The Oncologist* 2006;11:590-601.

74. Alston RD, Rowan S, Eden TOB, Moran A, Birch JM. Cancer incidence patterns by region and socioeconomic deprivation in teenagers and young adults in England. *British Journal of Cancer* 2007;96:1760- 66.

75. Barr RD. Common cancers in adolescents. *Cancer Treatment Reviews* 2007;33:597-602.

76. Barr RD, Holowaty EJ, Birch JM. Classification Schemes for Tumours Diagnosed in Adolescents and Young Adults. *Cancer* 2006;106(7):1425-30.

77. Birch JM, Alston RD, Kelsey AM, Quinn MJ, Babb P, McNally RJQ. Classification and incidence of cancers in adolescents and young adults in England 1979-1997. *British Journal of Cancer* 2002;87(11):1267-74.

78. CRUK. Bone and connective tissue cancer statistics - UK, 2011.

79. Blair V, Martin I, Shaw D, Winship I, Kerr D, Arnold J, et al. Hereditary Diffuse Gastric Cancer: Diagnosis and Management. *Clinical Gastroenterology and Hepatology* 2006;4(3):262-75.

80. Lynch HT, de la Chapelle A. Hereditary Colorectal Cancer. *New England Journal of Medicine* 2003;348(10):919-32.

81. Kramarova E, Stiller C. The International Classification of Childhood Cancer. *International Journal of Cancer* 1996;68:759-65.

82. Birch JM, Alston RD, Quinn MJ, Kelsey AM. Incidence of malignant disease by morphological type, in young persons aged 12- 24 years in England, 1979-1997. *European Journal of Cancer*

2003;39:2622-31.

83. Cancer Research UK. Leukaemia incidence statistics, 2012.

84. Cancer Research UK. Non-Hodgkin lymphoma statistics, 2012.

85. Cancer Research UK. Hodgkin lymphoma statistics, 2012.

86. Cancer Research UK. Brain and other CNS tumour statistics, 2012.

87. Capra M, Hargrave D, Bartels U, Hyder D, Huang A, Bouffet E. Central nervous system tumours in adolescents. *European Journal of Cancer* 2003;39(18):2643-50.

88. Barr RD. The adolescent with cancer. *European Journal of Cancer* 2001;37:1523-30.

89. Cancer Research UK. Bone and connective tissue cancer statistics, 2012.

90. Parkin DM, Stiller CA, Draper GJ, Bieber CA. The international incidence of childhood cancer. *International Journal of Cancer* 1988;42(4):511-20.

91. Steliarova-Foucher E, Stiller C, Kaatsch P, Berrino F, Coebergh JWW, Lacour B, et al. Geographical patterns and time trends of cancer incidence and survival among children and adolescents in Europe since the 1970s (the ACCIS project): an epidemiological study. *The Lancet* 2004;364:2097-105.

92. Cotterill SJ, Parker L, Malcolm AJ, Reid M, More L, Craft AW. Incidence and survival for cancer in children and young adults in the North of England, 1968-1995: a report from the Northern Region Young Persons/' Malignant Disease Registry. *Br J Cancer* 2000;83(3):397-403.

93. Stiller CA, Bielack SS, Jundt G, Steliarova-Foucher E. Bone tumours in European children and adolescents, 1978–1997. Report from the Automated Childhood Cancer Information System project. *European Journal of Cancer* 2006;42(13):2124-35.

94. National Cancer Intelligence Network. Soft Tissue Sarcomas: incidence and survival rates in England, 2011:2.

95. Stiller CA. Epidemiology of cancer in adolescents. *Medical and Pediatric Oncology* 2002;39:149-55.

96. Cancer Research UK. Testicular cancer incidence statistics, 2012.

97. Cancer Research UK. Ovarian cancer incidence statistics, 2012.

98. Arora RS, Alston RD, Eden TOB, Geraci M, Birch JM. Comparative incidence patterns and trends of gonadal and extragonadal germ cell tumors in England, 1979 to 2003. *Cancer* 2012;118(17):4290-97.

99. Cancer Research UK. Skin cancer statistics, 2012.

100. Birch JM. Patterns of Incidence of Cancer in Teenagers and Young Adults: Implications for Aetiology. *Cancer and the Adolescent*: Blackwell Science Ltd, 2007:11-31.

101. Chan K, Dassanayake B, Deen R, Wickramarachchi R, Kumarage S, Samita S, et al. Young patients with colorectal cancer have poor survival in the first twenty months after operation and predictable survival in the medium and long-term: Analysis of survival and prognostic markers. *World Journal of Surgical Oncology* 2010;8(1):82.

102. O'Connell JB, Maggard MA, Livingston EH, Yo CK. Colorectal cancer in the young. *The American Journal of Surgery* 2004;187(3):343-48.

103. Pentheroudakis G, Pavlidis N. Juvenile cancer: improving care for adolescents and young adults within the frame of medical oncology. *Annals of Oncology* 2005;16(181-188):181.

104. Reedijk AMJ, Janssen- Heijnen MLG, Louwman MWJ, Snepvangers Y, Hofhuis WJD, Coebergh JWW. Increasing incidence and improved survival of cancer in children and young adults in Southern Netherlands, 1973-1999. *European Journal of Cancer* 2005;41:760-69.

105. van Gaal JC, Bastiaannet E, Schaapveld M, Otter R, Kluin-Nelemans JC, de Bont ESJM, et al. Cancer in adolescents and young adults in north Netherlands (1989-2003): increased incidence, stable survival and high incidence of second primary tumours. *Annals of Oncology* 2008:1-9.

106. Stiller C, Desandres E, Danon SE, Izarzugaza I, Ratiu A, Vassileva- Valerianova Z, et al. Cancer incidence and survival in European adolescents (1978- 1997). Report from the Automated Childhood Cancer Information System project. *European Journal of Cancer* 2006;42:2006-18.

107. Jones WG, Appleyard I, Harnden P, Joffe JK, editors. *Germ Cell Tumours IV*. 1st ed. London: John Libbey & Company Ltd, 1997.

108. Kufe DW, Pollock RE, Weichselbaum RR, Bast Jr RC, Gansler TS, editors. *Cancer Medicine6*. 6th ed: B. C. Decker, 2003.

109. Robson B, Bradford M, Tomlinson R. Updating and revising the index of local deprivation. *London, DOE* 1998.

110. Townsend P, Phillimore P, Beattie A. Health and deprivation: inequality and the North. London: Croom-Helm. *Links* 1988.

111. Whiteson M. The Teenage Cancer Trust - advocating a model for teenage services. *European Journal of Cancer* 2003;39:2688-93.

112. Ramanujachar R, Richards S, Hann I, Goldstone A, Mitchell C, Vora A, et al. Adolescents with acute lymphoblastic leukaemia: Outcome on UK National Paediatric (ALL97) and Adult (UKALLXII/E2993) Trials. *Paediatric Blood and Cancer* 2007;48:254-61.

113. Klein-Geltink J, Shaw AK, Morrison HI, Barr RD, Greenberg ML. Use of paediatric versus adult oncology treatment centres by adolescents 15-19 years old: the Canadian Childhood Cancer Surveillance and Control Program. *European Journal of Cancer* 2005;41:404-10.

114. Lewis I, Morgan S. Models of Care and Specialized Units. In: Bleyer A, Barr RD, editors. *Cancer in Adolescents and Young Adults*. 1st ed. Berlin: Springer-Verlag, 2007:341-52.

115. Finlayson EVA, Goodney PP, Birkmeyer JD. Hospital volume and operative mortality in cancer surgery. *Archives of Surgery* 2003;138:721-25.

116. Fleissig A, Jenkins V, Catt S, Fallowfield L. Multidisciplinary teams in cancer care: are they effective in the UK? *The Lancet Oncology* 2006;7:935-43.

117. Halm EA, Lee C, Chassin MR. Is volume related to outcome in health care? A systematic review and methodologic critique of the literature. *Annals of Internal Medicine* 2002;137:511-20.

118. Haward RA, Amir Z, Borrill C, Dawson J, Scully J, West M, et al. Breast cancer teams: the impact of constitution, new cancer workload, and methods of operation on their effectiveness. *British Journal of Cancer* 2003;89:15-22.

119. Hillner BE, Smith TJ, Desch CE. Hospital and Physician Volume of Specialization and Outcomes in Cancer Treatment: Importance in Quality of Cancer Care. *Journal of Clinical Oncology* 2000;18(11):2327-40.

120. CLIC S. Caring for children and young peopl with cancer: hospital information, 2009.

121. NICE. Improving Outcomes in Children and Young People with Cancer: National Insititute for Health and Clinical Excellence, 2005:194.

122. TCT. The Teenage Cancer Trust, 2009.

123. National Health Service. NHS Specialised Services, 2012.

124. National Institute for Health and Clinical Excellence. Improving outcomes for people with sarcoma - the manual, 2006:142.

125. Bleyer A. Young Adult Oncology: The Patients and Their Survival Challenges. *A Cancer Journal for Clinicians* 2007;57:242-55.

126. CLIC S. A Long Way From Home: The impact of travel on children and young people with cancer: CLIC Sargent, 2010.

127. Cathcart PJ, van der Meulen J, Emberton M. Centralisation of cancer services vindicated. *British Medical Journal* 2010;340:340.

128. Stizenberg KB, Sigurdson ER, Egleson BL, Starkey RB, Meropol NJ. Centralization of Cancer Surgery: Implications for Patient Access to Optimal Care. *Journal of Clinical Oncology* 2009;27(28):4671-78.

129. Reynolds BC, Windebank KP, Leonard RCF, Wallace WHB. A comparison of self-reported satisfaction between adolescents treated in a “teenage” unit with those treated in adult or paediatric units. *Pediatric Blood & Cancer* 2005;44(3):259-63.

130. Smith S, Davies S, Wright D, Chapman C, Whiteson Mbe M. The experiences of teenagers and young adults with cancer—Results of 2004 conference survey. *European Journal of Oncology Nursing* 2007;11(4):362-68.

131. National Institute for Health and Clinical Excellence. Referral guidelines for suspected cancer, 2005.

132. DOH. Referral for suspected cancer: full guideline (part one), 2005.

133. DOH. Cancer waiting times.

134. RCR. Good practice guide for clinical oncologists. London: Royal College of Radiologists, 2003:19.

135. Mertens AC, Yasui Y, Neglia JP, Potter JD, Nesbit Jr ME, Ruccione K, et al. Late mortality experience in five-year survivors of childhood and adolescent cancer: the childhood cancer sirvivor study. *Journal of Clinical Oncology* 2001;19(13):3163-72.

136. Fey MF, Dreyling M, Group ObotEGW. Acute myeloblastic leukaemias and myelodysplastic syndromes in adult patients: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v158-v61.

137. Tallman MS, Gilliland DG, Rowe JM. Drug therapy for acute myeloid leukemia. *Blood* 2005;106(4):1154-63.

138. Craddock C, Augustson B, Basu S. Imatinib or transplant for chronic myeloid leukaemia? *The Lancet* 2003;362(9378):173.

139. Tilly H, Dreyling M, Group ObotEGW. Diffuse large B-cell non-Hodgkin's lymphoma: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v172-v74.

140. Dreyling M, Ghielmini M, Marcus R, Salles G, Vitolo U, Group ObotEGW. Newly diagnosed and relapsed follicular lymphoma: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2011;22(suppl 6):vi59-vi63.

141. Engert A, Eichenauer DA, Dreyling M, Group ObotEGW. Hodgkin's lymphoma: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv108-iv09.

142. CRUK. Treatment for meningioma, 2012.

143. CRUK. Treatment for pineal region tumours, 2012.

144. CRUK. Treatment for pituitary tumours, 2012.

145. CRUK. Treatment for crainopharyngioma, 2012.

146. CRUK. Treatment for ependymoma, 2012.

147. CRUK. Treatment for oligodendroglioma, 2012.

148. CRUK. Treatment for glioma (astrocytoma), 2012.

149. The Royal Marsden NHS Foundation Trust. Treatment of medulloblastoma/ PNET, 2012.

150. Wolff JEA, Sajedi M, Brant R, Coppes MJ, Egeler RM. Choroid plexus tumours. *Br J Cancer* 2002;87(10):1086-91.

151. BMJ. Osteosarcoma. *Best Practice*, 2012.

152. Bielack S, Carrle D, Casali PG, Group ObotEGW. Osteosarcoma: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv137-iv39.

153. Hogendoorn PCW, Group ObotEEW, committee: W, Athanasou N, Bielack S, De Alava E, et al. Bone sarcomas: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v204-v13.

154. Paulussen M, Bielack S, JÃ¼rgens H, Casali PG, Group ObotEGW. Ewing's sarcoma of the bone: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv140-iv42.

155. Saeter G. ESMO Minimum Clinical Recommendations for diagnosis, treatment and follow-up of Ewing's sarcoma of bone. *Annals of Oncology* 2003;14(8):1167-68.

156. BMJ. Soft-tissue sarcoma. *Best Practice*, 2012.

157. Casali PG, Blay J-Y, experts ObotECECPo. Soft tissue sarcomas: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v198-v203.

158. Schmoll HJ, Souchon R, Krege S, Albers P, Beyer J, Kollmannsberger C, et al. European consensus on diagnosis and treatment of germ cell cancer: a report of the European Germ Cell Cancer Consensus Group (EGCCCG). *Annals of Oncology* 2004;15(9):1377-99.

159. Schmoll H-J, Jordan K, Huddart R, Laguna MP, Horwich A, Fizazi K, et al. Testicular non-seminoma: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv89-iv96.

160. Schmoll H-J, Jordan K, Huddart R, Pes MPL, Horwich A, Fizazi K, et al. Testicular seminoma: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v140-v46.

161. Shelley MD, Burgon K, Mason MD. Treatment of testicular germ-cell cancer: a cochrane evidence-based systematic review. *Cancer Treatment Reviews* 2002;28(5):237-53.

162. Kamoshima Y, Sawamura Y. Update on current standard treatments in central nervous system germ cell tumors. *Current Opinion in Neurology* 2010;23(6):571-75 10.1097/WCO.0b013e32833ff522.

163. Kang CH, Kim YT, Jheon S-H, Sung S-w, Kim JH. Surgical Treatment of Malignant Mediastinal Nonseminomatous Germ Cell Tumor. *The Annals of Thoracic Surgery* 2008;85(2):379-84.

164. Dummer R, Hauschild A, Guggenheim M, Jost L, Pentheroudakis G, Group ObotEGW. Melanoma: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v194-v97.

165. Dummer R, Hauschild A, Pentheroudakis G. Cutaneous malignant melanoma: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv129-iv31.

166. Thomas JM, Newton-Bishop J, A'Hern R, Coombes G, Timmons M, Evans J, et al. Excision Margins in High-Risk Malignant Melanoma. *New England Journal of Medicine* 2004;350(8):757-66.

167. Flemming ID, Amonette R, Monaghan T, Flemming MD. Principles of management of basal and squamous cell carcinoma of the skin. *Cancer* 1994;49(2 Suppl):699-704.

168. Neville JA, Welch E, Leffell DJ. Management of nonmelanoma skin cancer in 2007. *Nat Clin Prac Oncol* 2007;4(8):462-69.

169. Braathen LR, Szeimies R-M, Basset-Seguin N, Bissonnette R, Foley P, Pariser D, et al. Guidelines on the use of photodynamic therapy for nonmelanoma skin cancer: An international consensus. *Journal of the American Academy of Dermatology* 2007;56(1):125-43.

170. Pacini F, Castagna MG, Brilli L, Pentheroudakis G, Group ObotEGW. Differentiated thyroid cancer: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv143-iv46.

171. Pacini F, Castagna MG, Brilli L, Pentheroudakis G, Group ObotEGW. Thyroid cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v214-v19.

172. Chan ATC, Felip E, Group ObotEGW. Nasopharyngeal cancer: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv123-iv25.

173. Licitra L, Felip E, Group ObotEGW. Squamous cell carcinoma of the head and neck: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv121-iv22.

174. Sorensen M, Felip E. Small-cell lung cancer: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2008;19(suppl 2):ii41-ii42.

175. D'Addario G, Felip E, Group ObotEGW. Non-small-cell lung cancer: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv68-iv70.

176. Balmana J, Diez O, Castiglione M, Group ObotEGW. BRCA in breast cancer: ESMO Clinical Recommendations. *Annals of Oncology* 2009;20(suppl 4):iv19-iv20.

177. Kataja V, Castiglione M, Group ObotEGW. Primary breast cancer: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv10-iv14.

178. Escudier B, Kataja V, Group ObotEGW. Renal cell carcinoma: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v137-v39.

179. Bellmunt J, Orsola A, Maldonado X, Kataja V, Group ObotEGW. Bladder cancer: ESMO Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v134-v36.

180. Aebi S, Castiglione M, Group ObotEGW. Newly and relapsed epithelial ovarian carcinoma: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv21-iv23.

181. Haie-Meder C, Morice P, Castiglione M, Group ObotEGW. Cervical cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v37-v40.

182. Balmana J, Castells A, Cervantes A, Group ObotEGW. Familial colorectal cancer risk: ESMO Clinical Practice Guidelines. *Annals of Oncology* 2010;21(suppl 5):v78-v81.

183. Labianca R, Nordlinger B, Beretta GD, Brouquet A, Cervantes A, Group ObotEGW. Primary colon cancer: ESMO Clinical Practice Guidelines for diagnosis, adjuvant treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v70-v77.

184. Sebag-Montefiore D, Stephens RJ, Steele R, Monson J, Grieve R, Khanna S, et al. Preoperative radiotherapy versus selective postoperative chemoradiotherapy in patients with rectal cancer (MRC CR07 and NCIC-CTG C016): a multicentre, randomised trial. *The Lancet* 2009;373(9666):811-20.

185. Okines A, Verheij M, Allum W, Cunningham D, Cervantes A, Group ObotEGW. Gastric cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 2010;21(suppl 5):v50-v54.

186. Eckel F, Jelic S, Group ObotEGW. Biliary cancer: ESMO Clinical Recommendation for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv46-iv48.

187. Jelic S, Group ObotEGW. Hepatocellular carcinoma: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv41-iv45.

188. Cascinu S, Jelic S, Group ObotEGW. Pancreatic cancer: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv37-iv40.

189. Stahl M, Oliveira J, Group ObotEGW. Esophageal cancer: ESMO Clinical Recommendations for diagnosis, treatment and follow-up. *Annals of Oncology* 2009;20(suppl 4):iv32-iv33.

190. Bleyer A, Ferrari A. Participation of adolescents with cancer in clinical trials. *Cancer Treatment Reviews* 2006;33:603-08.

191. Newburger PE, Elfenbein DS, Boxer LA. Adolescents with cancer; access to clinical trials and age-appropriate care. *Current Opinion in Pediatrics* 2002;14:1-4.

192. Whelan J, Fern LA. Poor accrual of teenagers and young adults into clinical trials in the UK. *The Lancet Oncology* 2008;9:306-07.

193. Ferrari A, Bleyer A. Participation of adolescents with cancer in clinical trials. *Cancer Treatment Reviews* 2007;33:603-08.

194. Ferrari A, Montello M, Budd T, Bleyer A. The challenges of clinical trials for adolescents and young adults with cancer. *Pediatric Blood and Cancer* 2008;50:1101-04.

195. McTiernan A. Issues surrounding the participation of adolescents with cancer in clinical trials in the UK. *European Journal of Cancer* 2003;12:233-39.

196. Fernandez CV, Barr RD. Adolescents and young adults with cancer: An orphaned population. *Paediatrics and Child Health* 2006;11(2):103-06.

197. Ferrari A, Dama E, Pession A, Rondelli R, Pascucci C, Locatelli F, et al. Adolescents with cancer in Italy: Entry into the national cooperative paediatric oncology group AIEOP trials. *European Journal of Cancer* 2009;45(3):328-34.

198. Oeffinger KC, Mertens AC, Sklar CA, Kawashima T, Hudson MM, Meadows AT, et al. Chronic Health Conditions in Adult Survivors of Childhood Cancer. *New England Journal of Medicine* 2006;355(15):1572-82.

199. Woodward E, Jessop M, Glaser A, Stark D. Late effects in survivors of teenage and young adult cancer: does age matter? *Annals of Oncology* 2011;22(12):2561-68.

200. Grant J, Cranston A, Horsman J, Furlong W, Barr N, Findlay S, et al. Health status and health-related quality of life in adolescent survivors of cancer in childhood. *Journal of Adolescent Health* 2006;38(5):504-10.

201. Sankila R, Garwicz S, Olsen JH, Döllner H, Hertz H, Kreuger A, et al. Risk of subsequent malignant neoplasms among 1,641 Hodgkin's disease patients diagnosed in childhood and adolescence: a population-based cohort study in the five Nordic countries. Association of the Nordic Cancer Registries and the Nordic Society of Pediatric Hematology and Oncology. *Journal of Clinical Oncology* 1996;14(5):1442-6.

202. Pratt CB, Meyer WH, Luo X, Cain AM, Kaste SC, Pappo AS, et al. Second malignant neoplasms occuring in survivors of osteosarcoma. *Cancer* 1997;80(5):960-65.

203. Haddy TB, Mosher RB, Dinndorf PA, Reaman GH. Second neoplasms in survivors of childhood and adolescent cancer are often treatable. *Journal of Adolescent Health* 2004;34(4):324-29.

204. Maltaris T, Beckman MW, Dittrich R. Fertility Preservation for Young Female Cancer Patients. *In Vivo* 2009;23(1):123-30.

205. Moffa F, Biacchiardi C, Fagioli F, Biasin E, Revelli A, Massobrio M, et al. Ovarian tissue cryostorage and grafting: an option to preserve fertility in pediatric patients with malignancies. *Paediatric Hematology and Oncology* 2007;24(1):29-44.

206. Robison LL, Green DM, Hudson MM, Meadows AT, Mertens AC, Packer RJ, et al. Long-Term Outcomes of Adult Survivors of Childhood Cancer. *Cancer* 2005;104(11):2557-64.

207. Katz A. Fertility Preservation in Young Cancer Patients. *American Journal of Nursing* 2009;109(4):44-47

208. Davies SM. Subsequent malignant neoplasms in survivors of childhood cancer: Childhood Cancer Survivor Study (CCSS) studies. *Pediatric Blood and Cancer* 2007;48(7):727-30.

209. Hawkins MM, Stevens MCG. The long term survivors. *British Medical Bulletin* 1996;52(4):898-923.

210. Jenkinson HC, Hawkins MM, Stiller CA, Winter DL, Marsden HB, Stevens MCG. Long-term population-based risks of second malignant neoplasms after childhood cancer in Britain. *British Journal of Cancer* 2004;91(11):1905-10.

211. Marina N. LONG-TERM SURVIVORS OF CHILDHOOD CANCER: The Medical Consequences of Cure. *Pediatric Clinics of North America* 1997;44(4):1021-42.

212. Dean BJF, Whitwell D. (i) Epidemiology of bone and soft-tissue sarcomas. *Orthopaedics and Trauma* 2009;23(4):223-30.

213. Moppett J, Oakhill A, Duncan AW. Second malignancies in children: the usual suspects? *European Journal of Radiology* 2001;38(3):235-48.

214. Neglia JP, Friedman DL, Yasui Y, Mertens AC, Hammond S, Stovall M, et al. Second malignant neoplasms in five-year survivors of childhood cancer: Childhood cancer survivor study. *Journal of the National Cancer Institute* 2001;93(8):618-29.

215. Cardous-Ubbink MC, Heinen RC, Bakker PJM, van den Berg H, Oldenburger F, Caron HN, et al. Risk of second malignancies in long-term survivors of childhood cancer. *European Journal of Cancer* 2007;43(2):351-62.

216. Suarez C, Bertolone SJ, Raj AB, Coventry S. Second malignant neoplasms in childhood acute lymphoblastic leukemia: Primitive neuroectodermal tumor of the chest wall with germline p53 mutation as a second malignant neoplasm. *American Journal of Hematology* 2004;76(1):52-56.

217. Meadows AT. Second tumours. *European Journal of Cancer* 2001;37(16):2074-81.

218. Bhatia S, Robison LL, Oberlin O, Greenberg M, Bunin G, Fossati-Bellani F, et al. Breast Cancer and Other Second Neoplasms after Childhood Hodgkin's Disease. *New England Journal of Medicine* 1996;334(12):745-51.

219. Sanna G, Lorizzo K, Rotmensz N, Bagnardi V, Cinieri S, Colleoni M, et al. Breast cancer in Hodgkin's disease and non-Hodgkin's lymphoma survivors. *Annals of Oncology* 2007;18(2):288-92.

220. Haddy TB, Mosher RB, Reaman GH. Osteoporosis in Survivors of Actue Lymphoblastic Leukaemia. *The Oncologist* 2001;6:278-85.

221. Kaste SC, Jones-Wallace D, Rose SR, Boyett JM, Lustig RH, Rivera GK, et al. Bone mineral decrements in survivors of childhood acute lymphoblastic leukaemia: frequency of occurrence and risk factors for their development. *Leukaemia* 2001;15:728-34.

222. Bleyer A, O'Leary M, Barr RD, Ries LAG. Cancer Epidemiology in Older Adolescents and Young Adults 15 to 29 Years of Age, Including SEER Incidence and Survival: 1975-2000. In: Institute NC, editor, 2006.

223. Desandes E, Lacour B, Sommelet D, White-Koning M, Velten M, Tretarre B, et al. Cancer adolescent pathway in France between 1988 and 1997. *European Journal of Oncology Nursing* 2007;11:74-81.

224. Chang JW, Asamura H, Kawachi R, Watanabe S-i. Gender difference in survival of resected non-small cell lung cancer: Histology-related phenomenon? *The Journal of Thoracic and Cardiovascular Surgery* 2009;137(4):807-12.

225. Micheli A, Mariotto A, Giorgi Rossi A, Gatta G, Muti P. The prognostic role of gender in survival of adult cancer patients. *European Journal of Cancer* 1998;34(14):2271-78.

226. Mungan N, Aben K, Schoenberg M, Visser O, Coebergh J, Witjes J, et al. Gender differences in stage-adjusted bladder cancer survival. *Urology* 2000;55(6):876.

227. Paulson EC, Wirtalla C, Armstrong K, Mahmoud NN. Gender Influences Treatment and Survival in Colorectal Cancer Surgery. *Dis Colon Rectum* 2009;52(12):1982-91,93 10.007/DCR.0b013e3181beb42a.

228. Press OA, Zhang W, Gordon MA, Yang D, Lurje G, Iqbal S, et al. Gender-Related Survival Differences Associated with EGFR Polymorphisms in Metastatic Colon Cancer. *Cancer Research* 2008;68(8):3037-42.

229. Sato N, Ito Y, Ioka A, Tanaka M, Tsukuma H. Gender Differences in Stomach Cancer Survival in Osaka, Japan: Analyses Using Relative Survival Model. *Japanese Journal of Clinical Oncology* 2009;39(10):690-94.

230. Coleman MP, Babb P, Sloggett A, Quinn MJ, De Stavola B. Socioeconomic Inequalities in Cancer Survival in England and Wales. *Cancer* 2001;91(1):208-16.

231. Coleman MP, Rachet B, Woods LM, Mitry E, Riga M, Cooper N, et al. Trends and socioeconomic inequalities in cancer survival in England and Wales up to 2001. *British Journal of Cancer* 2004;90:1367-73.

232. McKinney PA, Feltbower RG, Parslow RC, Lewis IJ, Picton SV, Kinsey SE, et al. Survival from childhood cancer in Yorkshire, UK:Effect of ethnicity and socio-economic status. *European Journal of Cancer* 1999;35(13):1816-23.

233. Whynes DK, Frew EJ, Manghan CM, Scholefield JH, Hardcastle JD. Colorectal cancer, screening and survival: the influence of socio-economic deprivation. *Public Health* 2003;117(6):389-95.

234. Wilkinson JR, Feltbower RG, Lewis IJ, Parslow RC, McKinney PA. Survival from adolescent cancer in Yorkshire, UK. *European Journal of Cancer* 2001;37:903-11.

235. Geraci M, Birch JM, A M, Eden TOB. Cancer mortality in 13 to 29 year olds in England and Wales, 1981-2005. *British Journal of Cancer* 2007;97:1588-94.

236. Sant M, Allemani C, De Angelis R, Carbone A, de SanJose S, Gianni AM, et al. Influence of morphology on survival for non-Hodgkin lymphoma in Europe and the United States. *European Journal of Cancer* 2008;44:579-87.

237. Gajdos C, Tartter PI, Bleiweiss IJ, Bodian C, Brower ST. Stage 0 to stage III breast cancer in young women. *Journal of the American College of Surgery* 2000;190(5):523-29.

238. Bleyer A. Older adolescents with cancer in North America: Deficits in outcome and research. *Pediatric Clinics of North America* 2002;49(5):1027-42.

239. NCI. A Snapshot of Adolescent and Young Adult Cancer. In: Assessment OoSPa, editor. *Snapshots*, 2008.

240. National Cancer Intelligence Network. National Cancer Data Repository, 2012.

241. National Cancer Intelligence Network. National Cancer Intelligence Network, 2012.

242. United Kingdom Association of Cancer Registries. UK Cancer Registration, 2012.

243. The Information Centre. HES online, 2012.

244. Ferlay J. Processing of data. In: Ferlay J, editor. *Cancer Incidence in Five Continents*, 2007.

245. Latent GOLD [program]. 4.5 version. Belmont, MA 2009.

246. The Brain Tumour Charity. The Brain Tumour Charity, 2012.

247. National Cancer Intelligence Network. Major surgical resections England, 2004-2006, 2011:48.

248. Miller Jr RG. *Survival analysis*: Wiley-Interscience, 2011.

249. Breslow NE. Analysis of survival data under the proportional hazards model. *International Statistical Review/Revue Internationale de Statistique* 1975:45-57.

250. Cox DR. Regression models and life-tables. *Journal of the Royal Statistical Society. Series B (Methodological)* 1972:187-220.

251. Nagelkerke N, Oosting J, Hart A. A simple test for goodness of fit of Cox's proportional hazards model. *Biometrics* 1984:483-86.

252. Kalbfleisch JD, Prentice RL. Marginal likelihoods based on Cox's regression and life model. *Biometrika* 1973;60(2):267-78.

253. Schoenfeld D. Partial residuals for the proportional hazards regression model. *Biometrika* 1982;69(1):239-41.

254. Hess KR. Graphical methods for assessing violations of the proportional hazards assumption in Cox regression. *Statistics in medicine* 1995;14(15):1707-23.

255. Stata Statistical Software [program]. College Station, TX, 2011.

256. Li R, Chambless L. Test for additive interaction in proportional hazards models. *Annals of epidemiology* 2007;17(3):227-36.

257. Cox DR, Snell EJ. A general definition of residuals. *Journal of the Royal Statistical Society. Series B (Methodological)* 1968:248-75.

258. Louis DN, Ohgaki H, Wiestler OD, Cavenee WK. *WHO Classification of Tumours, IARC WHO Classification of Tumours No 1*, 2007.

259. Louis D, Ohgaki H, Wiestler O, Cavenee W, Burger P, Jouvet A, et al. The 2007 WHO Classification of Tumours of the Central Nervous System. *Acta Neuropathol* 2007;114(2):97-109.

260. Halfon P, Eggli Y, Prêtre-Rohrbach I, Meylan D, Marazzi A, Burnand B. Validation of the Potentially Avoidable Hospital Readmission Rate as a Routine Indicator of the Quality of Hospital Care. *Medical Care* 2006;44(11):972-81 10.1097/01.mlr.0000228002.43688.c2.

261. Ahn HS, Yoon SJ, Jo HY, Lee HY, Lee J, Seo HJ. Association between unplanned readmission rate and volume of breast cancer operation cases. *International Journal of Clinical Practice* 2006;60(1):32-35.

262. Guinier D, Mantion GA, Alves A, Kwiatkowski F, Slim K, Panis Y. Risk Factors of Unplanned Readmission After Colorectal Surgery: A Prospective, Multicenter Study. *Dis Colon Rectum* 2007;50(9):1316-23.

263. Lemieux-Charles L, McGuire WL. What Do We Know about Health Care Team Effectiveness? A Review of the Literature. *Medical Care Research and Review* 2006;63(3):263-300.

264. Leng GC, Walsh D, Fowkes FG, Swainson CP. Is the emergency readmission rate a valid outcome indicator? *Quality in Health Care* 1999;8(4):234-38.

265. The Information Centre. Healthcare Resource Groups 4 (HRG4), 2012.

266. Department of Health. Payment by results, 2012.

267. Cascinelii N, Morabito A, Bufalino R, Esch EPV, Preda F, Vaglini M, et al. Prognosis of stage I melanoma of the skin. Who collaborating centres for evaluation of methods of diagnosis and treatment of melanoma. *International Journal of Cancer* 1980;26(6):733-39.

268. Garbe C, Peris K, Hauschild A, Saiag P, Middleton M, Spatz A, et al. Diagnosis and treatment of melanoma: European consensus-based interdisciplinary guideline. *European journal of cancer (Oxford, England : 1990)* 2010;46(2):270-83.

269. National Cancer Intelligence Network. Systemic Anti-Cancer Therapy Dataset (Chemotherapy), 2012.

270. Team TNCSA. Radiotherapy Dataset (RTDS), 2012.

271. Shama W, Lucchetta S. Psychosocial Issues of the Adolescent Cancer Patient and the Development of the Teenage Outreach Program (TOP). *Journal of Psychosocial Oncology* 2007;25(3):99-112.

272. Hokkanen H, Eriksson E, Ahonen O, Salantera S. Adolescents With Cancer: Experience of Life and How It Could Be Made Easier. *Cancer Nursing* 2004;27(4):325-35.

273. Gregor A, Thomson CS, Brewster DH, Stroner PL, Davidson J, Fergusson RJ, et al. Management and survival of patients with lung cancer in Scotland diagnosed in 1995: results of a national population based study. *Thorax* 2001;56(3):212-17.

274. Earle CC, Schrag D, Neville BA, Yabroff KR, Topor M, Fahey A, et al. Effect of Surgeon Specialty on Processes of Care and Outcomes for Ovarian Cancer Patients. *Journal of the National Cancer Institute* 2006;98(3):172-80.

275. Teenage Cancer Trust. BRIGHTLIGHT Study, 2012.

276. United Kingdom Association of Cancer Registries. Encore, 2012.

Appendix

Appendix A – Classification of tumours according to the Birch classification scheme

Table A 1: Classification of leukaemia according to the Birch classification scheme

1. Leukaemias			
Diagnostic Group		***Morphology code***	***T code restrictions***
1.1	Acute lymphoid leukaemia	9826, 9827, 9831, 9832, 9833, 9834, 9835, 9836,	
1.2	Acute myeloid leukaemia	9840, 9861, 9866, 9871, 9872, 9873, 9874, 9891,	
1.3	Chronic myeloid leukaemia	9863, 9875, 9876	
1.4	*Other and unspecified leukaemias*		
1.4.1	Other lymphoid leukaemia and lymphoid leukaemia NOS	9820, 9822, 9823, 9831	
1.4.2	Other myeloid leukaemia and myeloid leukaemia NOS	9860, 9862, 9864, 9865	
1.4.3	Other specified leukaemias	9733, 9742, 9805, 9830, 9841, 9842, 9850, 9867,	
1.4.4	Unspecified leukaemias	9800, 9801	

Table A 2: Classification of lymphomas according to the Birch classification scheme

2. Lymphomas			
Diagnostic Group		***Morphology code***	***T code restrictions***
2.1.	*Non-Hodgkins Lymphoma[NHL]:*		
2.1.1	NHL,specified Subtype	9593-9649, 9670-9714, 9716, 9717, 9718, 9719,	
2.1.2	Unspecified NHL	9590, 9591, 9592	
2.2.	*Hodgkin lymphoma [HL]:*		
2.2.1	HL specified sub-type	9651 - 9667	
2.2.2	HL NOS	9650	

Table A 3: Classification of central nervous system tumours according to the Birch classification scheme

3. Central Nervous System and Other Intracranial and Intraspinal Neoplasms			
Diagnostic Group		***Morphology code***	***T code restrictions***
3.1	*Astrocytoma*		
3.1.1	Pilocytic astrocytoma	9380	C72.3
		9421	None
3.1.2	Other specified low grade astrocytic tumours	9410-9420, 9422-9424	None
3.1.3	Glioblastoma and anaplastic astrocytoma	9401, 9440, 9441, 9442	None
3.1.4	Astrocytoma, NOS	9400	None
3.2	*Other glioma*		
3.2.1	Oligodendroglioma	9450, 9451	None
3.2.2	Other specified glioma	9381–9384, 9430 9444, 9460	None
3.2.3	Glioma, NOS	9380	Except C72.3
3.3.	Ependymoma	9391-9394	None
3.4	*Medulloblastoma and other PNET*		
3.4.1	Medulloblastoma	+9260, 9364, 9365, 9470-9473, 9474	C71.6
3.4.2	Supratentorial PNET	+9260, 9364, 9365, 9470-9473, 9474	C70.0 to C72.9 Except C71.6
3.5	*Other specified CNS, intracranial and intraspinal*		
3.5.1	Craniopharyngioma	9350, 9351, 9352	None
3.5.2	Other Pituitary tumours	Except 9350, 9060-9102, 9582	C75.1, C75.2
3.5.3	Pineal tumours	Except 9060-9102	C75.3
3.5.4	Choroid plexus tumours	9390	None
3.5.5	Meningioma	9530-9539	None
3.5.6	Nerve sheath tumours of CNS	9540-9570, 9571	C70.0-C72.9
3.5.7	Other specified intracranial and intraspinal neoplasms	8140, 8270-8281, 8300, 9161, 9480, 9505, 9493, 9508	C70.0-C72.9
3.6.	*Unspecified intracranial and intraspinal neoplasms*		
3.6.1	Unspecified malignant intracranial and intraspinal neoplasms (behaviour code 3 only)	8000-8004, 8010, 9990	C70.0-C72.9,
3.6.2	Unspecified benign and borderline intracranial and intraspinal neoplasms (behaviour code less than 3)	8000-8004, 8010, 9990	C70.0-C72.9,

Table A 4: Classification of osseous neoplasms according to the Birch classification scheme

4. Osseous and Chondromatous Neoplasms, Ewing Tumour and Other Neoplasms of Bone.			
Diagnostic Group		***Morphology code***	***T code restrictions***
4.1	Osteosarcoma	9180-9187, 9192, 9193, 9194, 9195	None
4.2	Chondrosarcoma	9220-9240, 9242, 9243	None
4.3	Ewing sarcoma	9260, 9364[+], 9365, 9470-9473, 9474	Not C70.0 to C72.9 None*
4.3.1	Ewing sarcoma of bone	C40.0 to C41.9	C40.0 to C41.9
4.3.2	Ewing sarcoma of specified site other than bone	Any except those in 4.3.1 or 4.3.3, 3.4.1 or	Any except those in 4.3.1 or 4.3.3, 3.4.1 or
4.3.3	Ewing sarcoma of unspecified site	C76.0 to C76.9, C78.7, C80.0, C80.9	C76.0 to C76.9, C78.7, C80.0, C80.9
4.4	*Other specified and unspecified bone tumours*		
4.4.1	Other specified bone tumours	8812, 9250, 9261, 9370, 9371, 9372	None
4.4.2	Unspecified bone tumours	8000-8004, 8800, 8801, 8803, 8805, 8806	C40.0 – C41.9

Table A 5: Classification of soft tissue sarcomas according to the Birch classification scheme

5. Soft Tissue Sarcomas			
Diagnostic Group		***Morphology code***	***T code restrictions***
5.1	*Fibromatous neoplasms*		
5.1.1	Fibrosarcoma	8810, 8811, 8813, 8814, 8815	None
5.1.2	[+]Malignant fibrous histiocytoma	8830, 8835, 8836	None
5.1.3	Dermatofibrosarcoma	8832, 8833	None
5.2	Rhabdomyosarcoma	8900-8920, 8921, 8991	None
5.3	*Other specified soft tissue sarcoma*		
5.3.1	Liposarcoma	8850-8881	None
5.3.2	Leiomyosarcoma	8890-8896	None
5.3.3	Synovial sarcoma	9040-9043	None
5.3.4	Clear cell sarcoma	9044	None
5.3.5	Blood vessel tumours	9120-9160	None
		9161	Except C70.0-C72.9
5.3.6	Nerve sheath tumours	9540-9570, 9571	Except C70.0-C72.9
5.3.7	Alveolar soft part sarcoma	9581	None
5.3.8	Other Specified	8804, 8840, 8990, 9014, 9015, 9170, 9251, 9252, 9561, 9580	None
5.4	Unspecified soft tissue sarcoma	8800-8803, 8805, 8806	Except (C40.0 – C41.9)

Table A 6: Classification of germ cell tumours according to the Birch classification scheme

6. Germ cell and trophoblastic neoplasms			
Diagnostic Group		***Morphology code***	***T code restrictions***
6.1	Germ cell and trophoblastic neoplasms of gonads.	9060-9102, 9103, 9104, 9105	C56.9, C62.0-C62.9
		†8010-8239, 8246-8580	C62.0-C62.9
6.2.	*Germ cell and trophoblastic neoplasms of non-gonadal sites.*		
6.2.1	Intracranial*	9060-9102, 9103, 9104, 9105	C70.0-C72.9, C75.1, C75.2, C75.3
6.2.2	Other non-gonadal sites	9060-9102, 9103, 9104, 9105	Any site except
			C56.9, C62.0-C62.9, C70.0-C72.9, C75.1,

Table A 7: Classification of melanoma and skin carcinoma according to the Birch classification scheme

7. Melanoma and Skin Carcinoma			
Diagnostic Group		***Morphology code***	***T code restrictions***
7.1.	Melanoma	8720-8780	None
7.2.	Skin carcinoma	8010-8589	C44.0-C44.9

Table A 8: Classification of carcinomas according to the Birch classification scheme

8. Carcinomas			
Diagnostic Group		***Morphology code***	***T code restrictions***
8.1.	Thyroid carcinoma		C73.9
8.2.	*Other carcinoma of head and neck*		
8.2.1	Nasopharyngeal carcinoma		C11.0-C11.9
8.2.2	Other sites in lip, oral cavity and pharynx.		C00.0 -C10.9,
			C12.0-C14.8
8.2.3.	Nasal cavity, middle ear, sinuses, larynx and other and ill-defined head and neck		C30.0 - C32.9, C76.0
8.3.	Carcinomas of trachea, bronchus and lung		C33.0-C34.9
8.4.	Carcinoma of breast		C50.0-C50.9
8.5.	*Carcinoma GU tract:*		
8.5.1	Carcinoma of kidney		C64.9
8.5.2	Carcinoma bladder		C67.0-C67.9
8.5.3	Carcinoma of ovary		C56.0
8.5.4	Carcinoma of cervix		C53.0-C53.9
8.5.5	Carcinoma of other and ill-defined sites in GU tract		C51.0-C52.9, C54.0-55.9, C57.0-C57.9, C60.0-C61.9, C63.0-C63.9, C65.9, C66.9, C68.0-
8.6.	*Carcinoma GI tract*		
8.6.1	Carcinoma of colon and rectum		C18.0-C21.8
8.6.2	Carcinoma stomach		C16.0-C16.9
8.6.3	Carcinoma of liver and intrahepatic bile ducts		C22.0-C22.9
8.6.4	Carcinoma pancreas		C25.0-C25.9
8.6.5	Carcinoma of other and ill-defined sites in GI tract		C15.0-C15.9, C17.0-C17.9, C23.0-C24.9, C26.0-C26.9
8.7.	*Carcinomas of other and ill-defined sites NEC*		
8.7.1	Adrenocortical carcinoma		C74.0-C74.9
8.7.2	Carcinoma of other and ill-defined sites, NEC		Any other C codes including C58.9 except

Table A 9: Classification of other and unspecified neoplasms according to the Birch classification scheme

9. Miscellaneous Specified Neoplasms NEC			
Diagnostic Group		***Morphology code***	***T code restrictions***
9.1	*Other paediatric and embryonal tumours NEC*		
9.1.1	Wilms tumours	8959, 8960 - 8962	
9.1.2	Neuroblastoma	9490, 9500	
9.1.3	Other paediatric and embryonal, NEC	8963, 8964,	
		8970-8972, 8973 8981, 9507, 9510-9523	
9.2.	*Other specified neoplasms NEC:*		
9.2.1	Paraganglioma and glomus	8680 – 8710, 8711	
9.2.2	Other specified gonadal tumours	8590 - 8650, 9000, 8670	
		*8240-8245	
9.2.3	Myeloma, mast cell tumours and miscellaneous lymphoreticular neoplasms NEC	9731- 9754, 9756 - 9764	
9.2.4	Other specified neoplasms NEC	8930-8951, 8980, 9020, 9050-9053, 9110, 9270-9330, 9342	
10. Unspecified Malignant Neoplasms NEC			
Diagnostic Group		***Morphology code***	***T code restrictions***
10	Unspecifed malignant neoplasms NEC	8000-8005, 9990	Any site except:
			C40.0-C41.9,
			C70.0-C72.9, C75.1, C75.3

Appendix B – Classification of procedures

CHEMOTHERAPY CODES

Table B 1: OPCS codes for chemotherapy related procedures recorded in HES data

OPCS code	Description
A106	Insertion of carmustine wafers in neoplasm of tissue of brain
A542	Injection of therapeutic substance into cerebrospinal fluid
M494	Introduction of therapeutic substance into bladder
T482	Introduction of cytotoxic substance into peritoneal cavity
X281	Intermittent intravenous infusion of therapeutic substance
X288	Intermittent infusion of therapeutic substance, other specified
X292	Continuous infusion of therapeutic substance NEC
X352	Intravenous chemotherapy
X384	Subcutaneous chemotherapy
X701	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 1
X702	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 2
X703	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 3
X704	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 4
X705	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 5
X708	Procurement of drugs for chemotherapy, other specified
X709	Procurement of drugs for chemotherapy, unspecified
X711	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 6
X712	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 7
X713	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 8
X714	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 9
X715	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 10
X718	Procurement of drugs for chemotherapy, other specified
X719	Procurement of drugs for chemotherapy, unspecified
X721	Delivery of complex chemotherapy for neoplasm including prolonged infusional treatment at first attendance
X722	Delivery of complex parenteral chemotherapy for neoplasm at first attendance
X723	Delivery of simple parenteral chemotherapy for neoplasm at first attendance
X723	Delivery of subsequent element of cycle of chemotherapy for neoplasm
X728	Delivery of chemotherapy for neoplasm, other specified
X729	Delivery of chemotherapy for neoplasm, unspecified
X731	Delivery of exclusively oral chemotherapy for neoplasm
X738	Delivery of oral chemotherapy for neoplasm, other specified
X739	Delivery of oral chemotherapy for neoplasm, unspecified

RADIOTHERAPY CODES

Table B 2: OPCS codes for chemotherapy related procedures recorded in HES data

OPCS code	Description
B022	Implantation of radioactive substance into pituitary gland
M712	Implantation of radioactive substance into prostate
P205	Implantation of radioactive substance into vagina
Q151	Introduction of radioactive substance into uterine cavity NEC
X651	Delivery of a fraction of total body irradiation
X652	Delivery of a fraction of intracavitary radiotherapy
X653	Delivery of a fraction of interstitial radiotherapy
X654	Delivery of a fraction of external beam radiotherapy NEC
X655	Oral delivery of radiotherapy for thyroid ablation
X656	Delivery of a fraction of intraluminal brachytherapy
X658	Radiotherapy delivery, other specified
X659	Radiotherapy delivery, unspecified
Y352	Introduction of iridium wire into organ NOC
Y353	Introduction of radium into organ NOC
Y354	Introduction of radioactive substance into organ for brachytherapy NOC
Y358	Introduction of removable radioactive material into organ, other specified
Y359	Introduction of removable radioactive material into organ, unspecified
Y361	Introduction of gold seeds into organ NOC
Y363	Radioactive seed implantation NOC
Y364	Introduction of non-removable radioactive substance into organ for brachytherapy NOC
Y911	Megavoltage treatment for complex radiotherapy
Y912	Megavoltage treatment for simple radiotherapy
Y913	Superficial or orthovoltage treatment for radiotherapy
Y914	Megavoltage treatment for adaptive radiotherapy
Y918	External beam radiotherapy, other specified
Y919	External beam radiotherapy, unspecified

MAJOR SURGICAL RESECTION CODES

Central nervous system and other intracranial and intraspinal neoplasms

Table B 3: Major resection (OPCS) codes for brain and CNS tumours, reported in HES

OPCS Code	Description
A01	Major excision of tissue of brain
A02	Excision of lesion of tissue of brain
A17	Therapeutic endoscopic operations on ventricle of brain
A29	Excision of lesion of cranial nerve
A38	Extirpation of lesion of meninges of brain
A43	Other extirpation of lesion of meninges of brain
A44	Partial extirpation of spinal cord
A51	Other operations on meninges of spinal cord
A57	Operations on spinal nerve root
A61	Extirpation of lesion of peripheral nerve

Osseous and chondromatous neoplasms, Ewing's sarcoma and other neoplasms of bone

Table B 4: Major resection (OPCS) codes for bone tumours, reported in HES

OPCS Code	Description
V06	Excision of maxilla
V07	Excision of bone of face
V14	Excision of mandible
V43	Extirpation of lesion of spine
W05	Prosthetic replacement of bone
W06	Total excision of bone
W08	Other excision of bone
W09	Extirpation of lesion of bone
X07	Amputation of arm
X08	Amputation of hand
X09	Amputation of leg
X10	Amputation of foot

Soft tissue sarcoma

Table B 5: Major resection (OPCS) codes for soft tissue sarcoma, reported in HES

OPCS Code	Description
X07	Amputation of arm
X08	Amputation of hand
X09	Amputation of leg
X10	Amputation of foot
T011	*Thoracoplasty*
T013	*Excision of lesion of chest wall*
T018	*Partial excision of chest wall, other specified*
T019	*Partial excision of chest wall, unspecified*
G01	Excision of oesophagus and stomach
G27	Total excision of stomach
G281	*Partial gastrectomy and anastomosis of stomach to duodenum*
G282	*Partial gastrectomy and anastomosis of stomach to transposed jejunum*
G283	*Partial gastrectomy and anastomosis of stomach to jejunum NEC*
G288	*Partial excision of stomach, other specified*
G289	*Partial excision of stomach, unspecified*
G49	Excision of duodenum
G50	Open extirpation of lesion of duodenum
G58	Excision of jejunum
G59	Extirpation of lesion of jejunum
G69	Excision of ileum
G70	Open extirpation of lesion of ileum
T312	*Excision of lesion of anterior abdominal wall and insert of prosthetic material into anterior abdominal wall*
T313	*Excision of lesion of anterior abdominal wall NEC*
T33	Open extirpation of lesion of peritoneum
T361	*Omentectomy*
T362	*Excision of lesion of omentum*
T371	*Excision of lesion of mesentery of small intestine*
T53	Extirpation of lesion of fascia
T65	Excision of tendon
T71	Excision of sheath of tendon
T77	Excision of muscle
T831	*Destruction of lesion of muscle*
T962	*Excision of lesion of soft tissue NEC*
T072	*Open excision of lesion of pleura*
T078	*Open excision of pleura, other specified*
T079	*Open excision of pleura, unspecified*
T312	*Excision of lesion of anterior abdominal wall and insert of prosthetic material into anterior abdominal wall*
T313	*Excision of lesion of anterior abdominal wall NEC*
T33	Open extirpation of lesion of peritoneum
X141	*Total exenteration of pelvis*
X142	*Anterior exenteration of pelvis*
X143	*Posterior exenteration of pelvis*
K221	*Excision of lesion of atrium*
K231	*Excision of lesion of wall of heart NEC*

Germ cell and trophoblastic neoplasms

Table B 6: Major resection (OPCS) codes for germ cell tumours, reported in HES

OPCS Code	Description
N05	Bilateral excision of testes
N06	Other excision of testis
N07	Extirpation of lesion of testis
Q07	Abdominal excision of uterus
Q08	Vaginal excision of uterus
Q221	*Bilateral salpingoophorectomy*
Q223	*Bilateral oophorectomy*
Q231	*Unilateral salpingoophorectomy NEC*
Q232	*Salpingoophorectomy of remaining solitary fallopian tube and ovary*
Q235	*Unilateral oophorectomy*
Q236	*Oophorectomy of remaining solitary ovary NEC*
Q241	*Salpingoophorectomy NEC*
Q243	*Oophorectomy NEC*
Q431	*Excision of wedge of ovary*
Q432	*Excision of lesion of ovary*
Q438	*Partial excision of ovary, other specified*
Q433	*Partial excision of ovary, unspecified*
Q491	*Endoscopic extirpation of lesion of ovary NEC*
T361	*Omentectomy*
X141	*Total exenteration of pelvis*
X142	*Anterior exenteration of pelvis*
X143	*Posterior exenteration of pelvis*
A01	Major excision of tissue of brain
A02	Excision of lesion of tissue of brain
A29	Excision of lesion of cranial nerve
A38	Extirpation of lesion of meninges of brain
A43	Other extirpation of lesion of meninges of brain
B06	Operations on pineal gland
E61	Open operations on mediastinum
T33	Open extirpation of lesion of peritoneum

Melanoma and skin carcinoma

Table B 7: Major resection (OPCS) codes for melanoma and skin carcinoma, reported in HES

Code	Description
B353	*Extirpation of lesion of nipple*
C101	*Excision of lesion of eyebrow*
C121	*Excision of lesion of eyelid NEC*
C126	*Wedge excision of lesion of eyelid*
E091	*Excision of lesion of external nose*
N012	*Excision of lesion of scrotum*
N271	*Excision of lesion of penis*
P054	*Excision of lesion of vulva NEC*
P111	*Excision of lesion of female peritoneum*
T293	*Extirpation of lesion of umbilicus*
S05	Microscopically controlled excision of lesion of skin
S06	Other excision of lesion of skin
F02	Extirpation of lesion of lip
D02	Extirpation of lesion of external ear

Carcinomas

Table B 8: Major resection (OPCS) codes for thyroid carcinomas, reported in HES

Code	Description
B08	Excision of thyroid gland
B09	Operations on aberrant thyroid tissue

Table B 9: Major resection (OPCS) codes for head and neck carcinomas, reported in HES

Site	**Code**	**Description**
Nasopharyngeal carcinoma	E19	Excision of pharynx
	E23	Other open operations on pharynx
	E24	Therapeutic endoscopic operations on pharynx
Other sites in lip, oral cavity and pharynx	E19	Excision of pharynx
	E23	Other open operations on pharynx
	E24	Therapeutic endoscopic operations on pharynx
	F22	Excision of tongue
	F23	Extirpation of lesion of tongue
	F28	Extirpation of lesion of palate
	F38	Extirpation of lesion of other part of mouth
	F44	Excision of salivary gland
	F45	Extirpation of lesion of salivary gland
Nasal cavity, middle ear, sinuses, larynx and other ill-defined sites in head and neck	D19	Extirpation of lesion of middle ear
	E29	Excision of larynx
	E30	Open extirpation of lesion of larynx
	E082	*Extirpation of lesion of internal nose NEC*
	E132	*Excision of lesion of maxillary antrum*
	E171	*Excision of nasal sinus NEC*
	E172	*Excision of lesion of nasal sinus NEC*

Table B 10: Major resection (OPCS) codes for carcinomas of the trachea, bronchus, pleura and lung, reported in HES

Code	**Description**
E39	Partial excision of trachea
E441	*Excision of carina*
E43	Open operations on trachea
E54	Excision of lung
E552	*Open excision of lesion of lung*
E558	*Open extirpation of lesion of lung, other specified*
E559	*Open extirpation of lesion of lung, unspecified*
T013	*Excision of lesion of chest wall*
E461	*Sleeve resection of bronchus and anastomosis HFQ*
E463	*Excision of lesion of bronchus NEC*

Table B 11: Major resection (OPCS) codes for carcinomas of the breast, reported in HES

Code	**Description**
B27	Total excision of breast
B28	Other excision of breast
B341	*Subareolar excision of mammillary duct*
B342	*Excision of mammillary duct NEC*
B343	*Excision of lesion of mammillary duct*
B352	*Excision of nipple*
B37	Other operations on breast
B40	Destruction of lesion of breast

Table B 12: Major resection (OPCS) codes for carcinomas of the GU tract, reported in HES

Site	Code	Description
Kidney	M02	Total excision of kidney
	M038	*Partial excision of kidney, other specified*
	M039	*Partial excision of kidney, unspecified*
	M042	*Open excision of lesion of kidney NEC*
	M104	*Endoscopic cryoablation of lesion of kidney*
	M181	*Total ureterectomy*
	M182	*Excision of segment of ureter*
	M183	*Secondary ureterectomy*
	M252	*Open excision of lesion of ureter NEC*
Bladder	M34	Total excision of bladder
	M358	*Partial excision of bladder, other specified*
	M359	*Partial excision of bladder, unspecified*
	M411	*Open extirpation of lesion of bladder*
Ovary	Q07	Abdominal excision of uterus
	Q08	Vaginal excision of uterus
	Q221	*Bilateral salpingoophorectomy*
	Q223	*Bilateral oophorectomy*
	Q231	*Unilateral salpingoophorectomy NEC*
	Q232	*Salpingoophorectomy of remaining solitary fallopian tube and ovary*
	Q235	*Unilateral oophorectomy*
	Q236	*Oophorectomy of remaining solitary ovary NEC*
	Q241	*Salpingoophorectomy NEC*
	Q243	*Oophorectomy NEC*
	Q431	*Excision of wedge of ovary*
	Q432	*Excision of lesion of ovary*
	Q438	*Partial excision of ovary, other specified*
	Q433	*Partial excision of ovary, unspecified*
	Q491	*Endoscopic extirpation of lesion of ovary NEC*
	T361	*Omentectomy*
	X141	*Total exenteration of pelvis*
	X142	*Anterior exenteration of pelvis*
	X143	*Posterior exenteration of pelvis*
Cervix	*P171*	*Total colpectomy*
	P172	*Partial colpectomy*
	Q01	Excision of cervix uteri
	Q07	Abdominal excision of uterus
	Q08	Vaginal excision of uterus
	X141	*Total exenteration of pelvis*
	X142	*Anterior exenteration of pelvis*
	X143	*Posterior exenteration of pelvis*
Other and ill-defined sites in GU tract	*M181*	*Total ureterectomy*
	M182	*Excision of segment of ureter*
	M183	*Secondary ureterectomy*
	M61	Open excision of prostate
	M621	*Open extirpation of lesion of prostate*
	M623	*Prostatotomy*

	M65	Endoscopic resection of outlet of male bladder
	M72	Excision of urethra
	N26	Amputation of penis
	P051	*Total excision of vulva*
	P052	*Partial excision of vulva*
	P054	*Excision of lesion of vulva NEC*
	P06	Extirpation of lesion of vulva
	P11	Extirpation of lesion of female peritoneum
	P17	Excision of vagina
	P20	Extirpation of lesion of vagina
	Q07	Abdominal excision of uterus
	Q08	Vaginal excision of uterus
	Q09	Other open operations on uterus
	Q22	Bilateral excision of adnexa of uterus
	Q23	Unilateral excision of adnexa of uterus
	Q24	Other excision of adnexa of uterus
	Q52	Operations on broad ligament of uterus
	X141	*Total exenteration of pelvis*
	X142	*Anterior exenteration of pelvis*
	X143	*Posterior exenteration of pelvis*

Table B 13: Major resection (OPCS) codes for carcinomas of the GI tract, reported in HES

Site	Code	Description
Colon and rectum	H04	Total excision of colon and rectum
	H05	Total excision of colon
	H06	Extended excision of right colon
	H07	Other excision of right hemicolon
	H08	Excision of transverse colon
	H09	Excision of left hemicolon
	H10	Excision of sigmoid colon
	H11	Other excision of colon
	H29	Subtotal excision of colon
	H33	Excision of rectum
	H044	*Trans-sphicteric anastomosis of colon to anus*
	X141	*Total exenteration of pelvis*
	X142	*Anterior exenteration of pelvis*
	X143	*Posterior exenteration of pelvis*
Stomach	G01	Excision of oesophagus and stomach
	G27	Total excision of stomach
	G281	*Partial gastrectomy and anastomosis of stomach to duodenum*
	G282	*Partial gastrectomy and anastomosis of stomach to transposed jejunum*
	G283	*Partial gastrectomy and anastomosis of stomach to jejunum NEC*
	G288	*Partial excision of stomach, other specified*
	G289	*Partial excision of stomach, unspecified*
Liver and intrahepatic bile ducts	J02	Partial excision of liver
	J03	Extirpation of lesion of liver
	J27	Excision of bile duct
	J28	Excision of lesion of bile duct
Pancreas	J55	Total excision on pancreas
	J56	Excision of head of pancreas
	J57	Other partial excision of pancreas
	J58	Extirpation of lesion of pancreas
Other and ill-defined sites in the GI tract	G01	Excision of oesophagus and stomach
	G02	Total excision of oesophagus
	G03	Partial excision of oesophagus
	G04	Open extirpation of lesion of oesophagus
	G49	Excision of duodenum
	G50	Open extirpation of lesion of duodenum
	G58	Excision of jejunum
	G59	Extirpation of lesion of jejunum
	G69	Excision of ileum
	G70	Open extirpation of lesion of ileum
	H47	Excision of anus
	H48	Excision of lesion of anus

Table B 14: Major resection (OPCS) codes for carcinomas of other & ill-defined sites not elsewhere classified (NEC), reported in HES

Site	Code	Description
Adrenocortical carcinoma	B22	Excision of adrenal gland
	B23	Operations on aberrant adrenal tissue
	B251	Excision of lesion of adrenal gland
Other carcinomas NEC	B08	Excision of thyroid gland
	B09	Operations on aberrant thyroid tissue
	B27	Total excision of breast
	B28	Other excision of breast
	B14	Excision of parathyroid gland
	B18	Excision of thymus gland
	H04	Total excision of colon and rectum
	H05	Total excision of colon
	H06	Extended excision of right colon
	H07	Other excision of right hemicolon
	H08	Excision of transverse colon
	H09	Excision of left hemicolon
	H10	Excision of sigmoid colon
	H11	Other excision of colon
	H29	Subtotal excision of colon
	H33	Excision of rectum
	J02	Partial excision of liver
	J03	Extirpation of lesion of liver
	J18	Excision of gall bladder
	J27	Excision of bile duct
	J28	Excision of lesion of bile duct
	K221	*Excision of lesion of atrium*
	K231	*Excision of lesion of wall of heart NEC*
	Q01	Excision of cervix uteri
	Q07	Abdominal excision of uterus
	Q08	Vaginal excision of uterus
	Q22	Bilateral excision of adnexa of uterus
	Q23	Unilateral excision of adnexa of uterus
	Q24	Other excision of adnexa of uterus
	T072	*Open excision of lesion of pleura*
	T078	*Open excision of pleura, other specified*
	T079	*Open excision of pleura, unspecified*
	T312	*Excision of lesion of anterior abdominal wall and insert of prosthetic material into anterior abdominal wall*
	T313	*Excision of lesion of anterior abdominal wall NEC*
	T33	Open extirpation of lesion of peritoneum
	X141	*Total exenteration of pelvis*
	X142	*Anterior exenteration of pelvis*
	X143	*Posterior exenteration of pelvis*