# THE ROLE OF ORGANISATIONAL AND RESOURCE FACTORS IN DETERMINING LUNG CANCER OUTCOMES

BY

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# ABSTRACT

Lung cancer outcomes in the UK show significant variation which are not entirely explained by case mix. Differences in access to lung cancer services contribute. However, the specific factors that underlie the relationship between service organisation and disease outcomes are not known.

The systematic review highlights that co-ordinated access to specialist care is likely to be an important determinant of patient outcomes. In addition, a bundle of service factors, rather than an individual factor is a more robust proxy for hospital infrastructure quality. This hypothesis is explored through the creation of a novel organisational score. When adjusted for patient factors a higher score is associated with higher curative intent treatment rates, increased likelihood of patients receiving treatment within 62 days and improved one-year survival.

To achieve these improved outcomes national variation in the provision of services and workforce as well as gaps in the optimal care of stage III patients in England need to be addressed. As well as aligning units with national commissioning guidance, qualitative work into decision making suggests that clinician preconceptions and nihilistic attitudes also require consideration.

This work shows that inequity in access to essential services exists in the UK and this has a direct impact on patients.

# DEDICATION

This thesis is dedicated to my husband Tochukwu Adizie

# ACKNOWLEDGMENTS

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ABBREVIATIONS

| | |
|---|---|
| ACCP | American College of Chest Physicians |
| ALK | Anaplastic lymphoma kinase |
| BTS | British Thoracic Society |
| CCP | Care Coordination Programme |
| CEEU | Clinical Effectiveness and Evaluation Unit |
| CHART | Continuous Hyper-fractionated Accelerated Radiotherapy |
| CI | Confidence Interval |
| COPD | Chronic obstructive pulmonary disease |
| COSD | Cancer Outcomes and Services Dataset |
| CPET | Cardio-pulmonary exercise test |
| CRUK | Cancer Research United Kingdom |
| CT | Computerised tomography |
| CS | Cardiac Surgeon |
| DAPs | Diagnostic Assessment Programmes |
| EBUS | Endobronchial Ultrasound |
| ECOG | Eastern Cooperative Oncology Group |
| EGFR | Epidermal growth factor receptor |
| ESMO | European Society for Medical Oncology |
| EUS | Endoscopic Ultrasound |
| FEV1 | Forces Expiratory Volume in 1 second (L/min) |
| GP | General Practitioner |
| GS | General Surgeon |
| Gy | Gray |

| | |
|---|---|
| HES | Hospital Episode Statistics |
| HQuIP | Healthcare Quality Improvement Programme |
| HR | Hazard Ratio |
| HV(H)/(S) | High volume (hospital)/(surgeon) |
| IASLC | International Association for the Study of Lung Cancer |
| ICD-10 | International Classification of Diseases version 10 |
| IMRT | Intensity modulated radiation therapy |
| IQR | Inter quartile range |
| LAT | Local Anaesthetic Thoracoscopy |
| LCNS | Lung cancer clinical nurse specialist |
| LV(H)/(S) | Low volume (hospital)/(surgeon) |
| MD(T)/(C) | Multidisciplinary (team)/(clinic) |
| NCCN | National Comprehensive Cancer Network |
| NCDB | National Cancer Database |
| NCRAS | National Cancer Registration and Analysis Service |
| NHS | National Health Service |
| NCICCC | National Cancer Institute designated cancer centres |
| NICE | National Institute for Health and Clinical Excellence |
| NLCA | National Lung Cancer Audit |
| NOLCP | National Optimal Lung Cancer Pathway |
| NRT | Nicotine replacement therapy |
| NSCLC | Non-small cell lung cancer |
| NSCLC-NOS | Non-small cell lung cancer not otherwise specified |
| ONS | Office of National Statistics |

| | |
|---|---|
| OPCS4 | Surgical Classification of Operations and Procedures version 4 |
| OR | Odd Ratio |
| PA | Programmed Activities |
| PDL | Programmed Death Ligand |
| PET-CT | Positron Emitting Tomography-Computerised Tomography |
| PR | Pulmonary Rehabilitation |
| PS | Performance Status |
| RCP | Royal College of Physicians, London |
| RCT | Randomised Controlled Trial |
| RDP | Rapid Diagnostic Programme |
| RR(R) | Relative Risk (Ratio) |
| RTDS | National Radiotherapy Dataset |
| SABR | Stereotactic Ablative Radiotherapy |
| SACT | Systemic Anti-Cancer Dataset |
| SCTS | Society for Cardiothoracic Surgery |
| SDM | Shared Decision Making |
| SEER | Surveillance Epidemiology and End Results programme |
| SES | Socio-economic status |
| TBNA | Trans-Bronchial Needle Aspiration (ultrasound guided) |
| TS | Thoracic Surgeon |
| VAT | Video Assisted Thoracoscopy |
| WTE | Whole time equivalent |

## PUBLICATIONS ARISING

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## CONFERENCE CONTRIBUTIONS

Adizie J, Bishopp A, Woolhouse I, *et al* The impact of hospital resources and organisation of care on patient outcome: a systematic review and application to lung cancer pathways *Thorax* 2018;73: A72-A73.

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Adizie, J. et al. A local qualitative study exploring facilitators and barriers to effective lung cancer decision making. Lung Cancer, Volume 127, S6.

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AUTHOR'S DECLARATION

All material within this thesis previously published has been indicated where appropriate. The contents of this thesis are all my own original work and any contributions by others have been clearly indicated. I can confirm that this thesis has not been submitted for a higher degree at any other university.

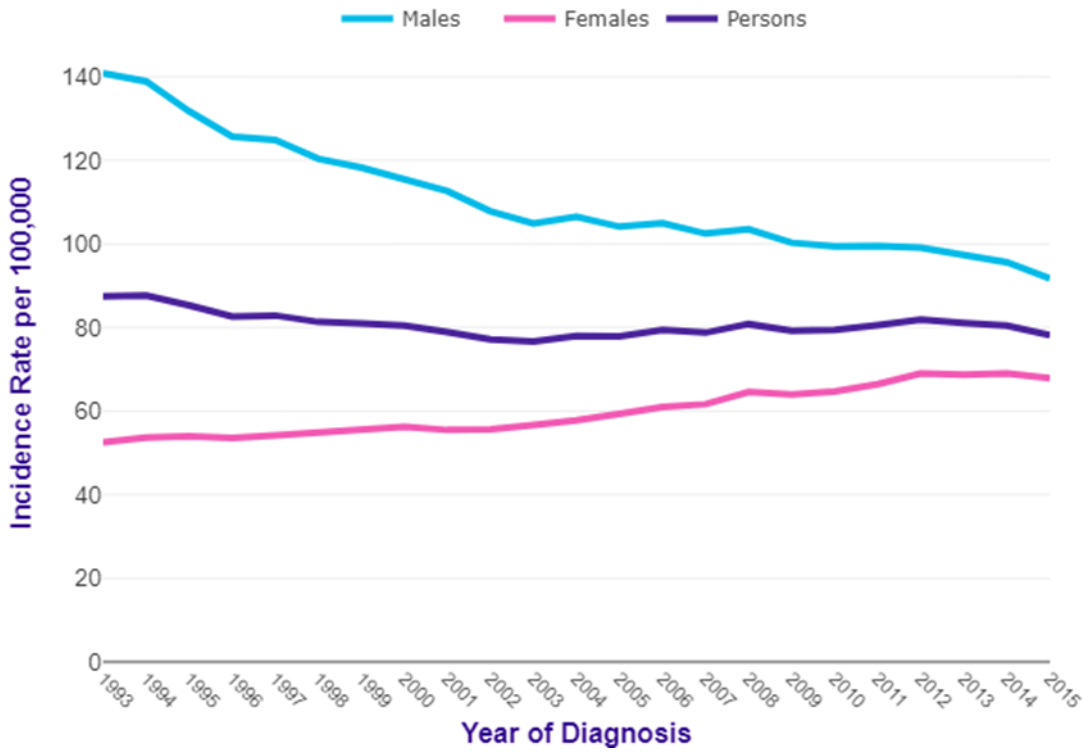
# CHAPTER 1 INTRODUCTION

## 1.1 Epidemiology of lung cancer

Lung cancer is the most common cancer worldwide with 1.8 million new cases diagnosed in 2012. (1) The number of worldwide lung cancer deaths is projected to increase from 1.6 million in 2012 to 3 million in 2035. (2) In England, lung cancer accounts for approximately 28, 000 deaths per year. (3) As such it is the most common cause of cancer death in England and worldwide. Yet, current survival rates for lung cancer are the second lowest out of twenty common cancers in the UK. Figures from the most recent National Lung Cancer Audit report a one-year survival of 37% which has not shown much improvement over the last forty years. (4)

Currently, slightly more men are diagnosed with lung cancer than women. (3) In 2016, 47% of cases were female and 53% male. (4) In males the incidence rate has decreased from the early 1990's. However, in females, the rate has increased by an average of ~ 33% in those over 50 years old. (3) This corresponds to the pattern of smoking in the UK and a subsequent increase in lung cancer death is projected for women over the next twenty years. (2) Figure 1.1 demonstrates age standardised rates of lung cancer for males and females over time.

**Figure 1.1 European age standardised incidence rates in the UK, 1993-2015 (taken from Cancer Research UK, 2013)** (3)




The median age of presentation is 73 years old with approximately two thirds of individuals being diagnosed over the age of 70. (4) The majority of patients in the UK are white males with an age standardised rate of 62 per 100,000 compared to 40 per 100,000 for black males and 30 per 100,000 for Asian males. (5) However, the accuracy of this data is questionable given that approximately one third of ethnicity data is missing from national datasets.

Studies have shown that lung cancer is directly correlated with socio-economic status. (6) In the UK, people in the most deprived quintile are twice as likely to develop lung cancer as those in the most affluent. (3) It is estimated that there would be 11,700 fewer lung cancer cases each year in England in 2006-2010 if all people experienced the same incidence rates as the least deprived. (3) This difference is thought to be because of increased rates of smoking

in deprived areas, nature of employment (manual versus professional), educational attainment and access to health services.

## 1.2 Aetiology of lung cancer

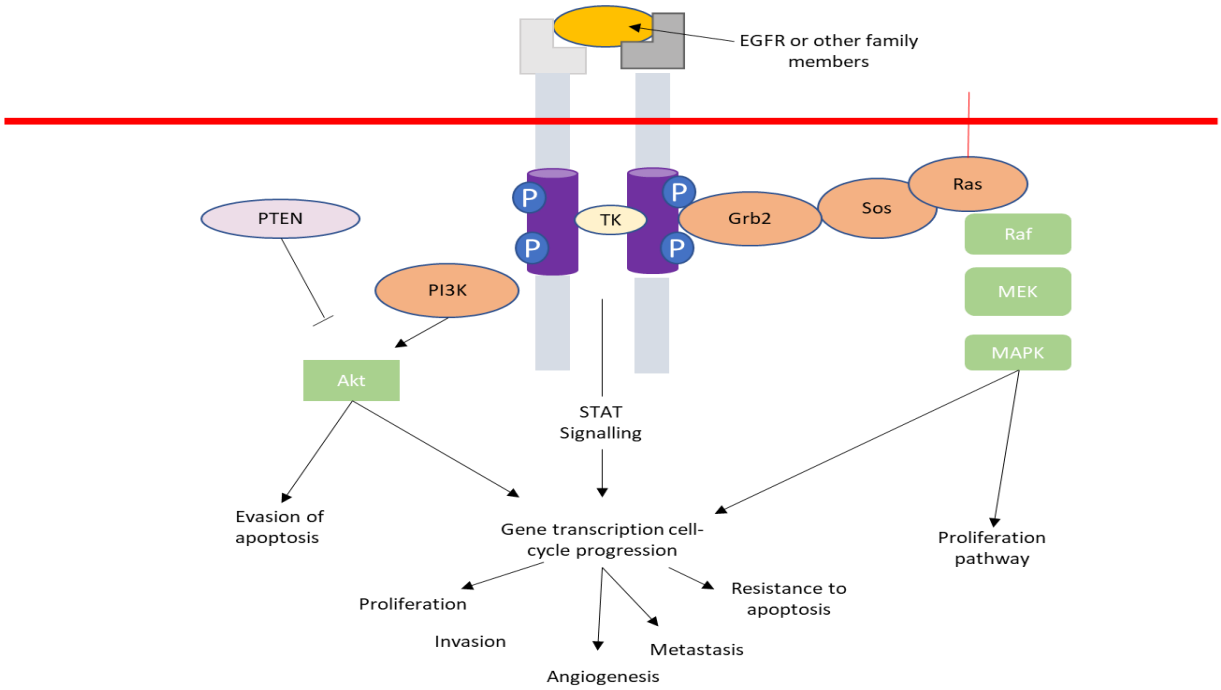
Tobacco smoking is attributable to 85% of lung cancer cases. (7) Approximately 19% of adults in the UK currently smoke which equates to an estimated 9.4 million UK adult smokers. (3) This is likely to be an underestimate of the true number as data is self-reported. (3) A systematic review investigating the concordance between self-reported smoking status and that determined through objectives measures (such as Continine in biological fluids) found a difference in rates between 1%-47%. (8)

The mechanism by which tobacco smoke leads to genetic mutation is a complex multistep process. (7) However, only 10-20% of smokers develop cancer, suggesting genetic determinants of susceptibility. (7) The carcinogenic process is driven by the accumulation of genetic and epigenetic alterations that result in the dysregulation of key oncogenes, tumour suppressor genes and DNA repair genes. (9) Changes of cytochrome P450 1A1 gene and GSTM1 homozygous deletion are amongst some of the many polymorphisms associated with increased lung cancer risk. (7)

Genetic abnormalities associated with lung cancer occur in the context of altered signalling pathways. (10) Oncogenes drive stimulatory signalling pathways leading to cell proliferation and prevention of apoptosis. (10) Mutated oncogenic proteins have abnormal functions and ‘oncogene addiction’ occurs when tumour cells are dependent on these abnormal oncogene functions for their sustained proliferation and survival. (10) These pathways include those

involving epidermal growth factor receptor (EGFR), anaplastic lymphoma fusion proteins and thyroid transcription factor 1. (7) The key mechanisms in the EGFR pathway are illustrated in figure 1.2. The components of such pathways are becoming increasingly important with regards to targeted therapy which will be discussed in section 1.6.4.

**Figure 1.2 Epidermal growth factor receptor pathway (modified from Brambilla et al. Pathogenesis of lung cancer signalling pathways: a roadmap for therapies. Eur Respir J. 2009;33:1485-97) (7)**




Ligands such as epidermal growth factor (EGF) bind to the domain (TK) leading to activation and receptor transphosphorylation. This creates docking sites for the adaptor proteins, Grb2 and Sos, which recruit Ras and phosphatidylinositol 3-kinase (PI3K), leading to the formation of two major signal pathway branches- Ras/mitogen-activated kinase-like protein (MAPK) and PI3K/Akt. This results in proliferation, evasion of apoptosis and angiogenesis.

The probability of incurring these genetic alterations and hence an individuals' risk of malignancy is dependent on genetic heterogeneity as well as epigenetic variability, including DNA methylation, histone modifications and non-coding RNA expression. (9)

Approximately 7000 people, in the UK, develop lung cancer unrelated to smoking each year. (11) Other important risk factors include genetic factors, occupational agents and environmental factors such as Environmental Tobacco Smoke (ETS) or second-hand smoke. (3)

### 1.2.1 Environmental Factors

It is estimated that 15% of lung cancers are linked to ETS in non-smokers. (12) One meta-analysis showed lung cancer risk in never smokers is as high as 31% greater in those exposed to ETS at home or work compared to those not exposed. (13) Other environmental agents that have been linked to lung cancer include ionising radiation, radon and X ray radiation. (3)

In terms of cases linked to occupational exposure it is thought that this equates to approximately 21% of men and 4-5% of women in the UK. (3) These include exposure to asbestos, silica, diesel engine exhaust and substances from metal and pesticide production. The most commonly linked occupational exposure to lung cancer is asbestos accounting for 6-8% of lung cancer deaths. (14)

### 1.2.2 Genetic factors

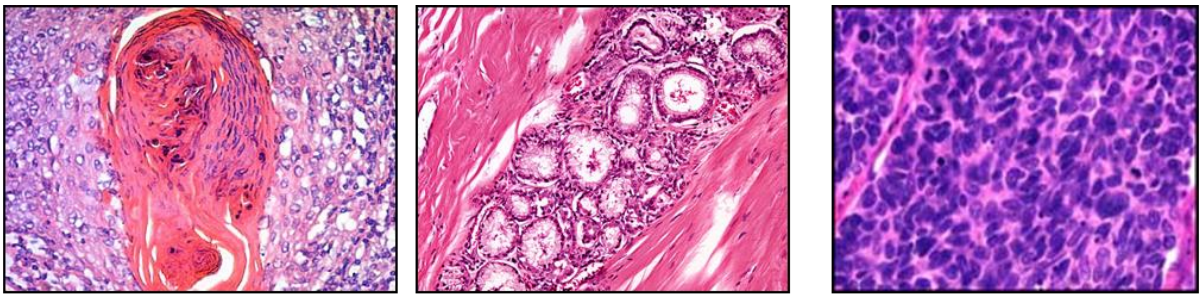
25% of lung cancer cases worldwide are not attributable to smoking. (7) Studies have shown that the risk is 82% higher in people whose sibling has had lung cancer and 25-37% higher for a parent. (15) This association was shown to be independent of smoking. (15) The cause has not been conclusively identified. (7) However, a susceptibility at the genetic locus at 6q23-25 has been reported and differences in the mutation patterns in key genes (such as TP53, KRAS

and EGFR) between smokers and never smokers has been found. (7,16) Further research is required to fully understand aetiological mechanisms in what is increasingly being considered a distinct disease from the more common tobacco related forms of lung cancer. (7)

## 1.3 Histology and staging of lung cancer

Lung cancer is classified into non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC). NSCLC is the most common subtype and accounted for 88.5% of cases in 2016. (4) NSCLC has two major subtypes: squamous cell carcinoma and adenocarcinoma. Examples of the histological appearance of the major types are shown in Figure 1.3.

**Figure 1.3 Histological appearance of the major lung cancer subtypes**




Obtaining a histological confirmation of the lung cancer is vital to treatment planning. Latest data from the NLCA demonstrate that 21% of patients in the UK with early stage lung cancer that are considered fit did not receive a pathological diagnosis. Across individual

organisations (excluding tertiary trusts) the results, adjusted for casemix, varied from 44% to 0%. (17)

The extent of a person's lung cancer is another important determinant of treatment planning and prognosis. The stage classification provides a system for categorising the anatomic extent of the cancer. The International Association for the Study of Lung Cancer group (IASLC) published the eighth edition of the TNM staging system in January 2017, and a summary of the staging criteria are shown in Table 1.1. (18) In 2016, over half of newly diagnosed patients presented with Stage IV disease. (4)

**Table 1.1 The 8th TNM Staging System**

| **Stage** | **Description** |
|---|---|
| **Tx** | **Tumour in sputum/bronchial washings but not visible on imaging or bronchoscopy** |
| **$T_0$** | **No evidence of tumour** |
| **$T_{is}$** | **Carcinoma in situ** |
| **$T_1$** | **≤ 3cm surrounded by lung/visceral pleura, not involving main bronchus** |
| *$T_{1a(mi)}$)* | *Minimally invasive carcinoma* |
| *$T_{1a}$* | *≤1cm* |
| *$T_{1b}$* | *>1 to ≤2cm* |
| *$T_{1c}$* | *>2 to ≤3cm* |
| **$T_2$** | **>3 to ≤5cm or involvement of main bronchus without carina, regardless of distance to carina or invasion of visceral pleura or atelectasis or post obstructive pneumonitis extending to hilum** |
| *$T_{2a}$* | *>3 to ≤4cm* |
| *$T_{2b}$* | *>4 to ≤5cm* |
| **$T_3$** | **>5 to ≤7cm in greatest dimension or tumour of any size that involves the chest wall, pericardium, phrenic nerve or satellite nodules in the same lobe.** |
| **$T_4$** | **>7cm in greatest dimension or any tumour with invasion of mediastinum, diaphragm, heart, great vessels, recurrent laryngeal nerve, carina, trachea, oesophagus, spine or separate tumour in different lobe of ipsilateral lung** |
| **$N_1$** | **Ipsilateral peri-bronchial and/or hilar nodes and intrapulmonary nodes.** |
| **$N_2$** | **Ipsilateral mediastinal and/or subcarinal nodes** |
| **$N_3$** | **Contralateral mediastinal or hilar; ipsilateral/contra-lateral/scalene/supraclavicular** |
| **$M_1$** | **Distant metastasis** |
| *$M_{1a}$* | *Tumour in contralateral lung or pleural/pericardial nodule/malignant effusion* |
| *$M_{1b}$* | *Single extra-thoracic metastasis, including non-regional lymph node* |
| *$M_{1c}$* | *Multiple extra-thoracic metastases in one or more organs.* |

## 1.4 Clinical presentation

The commonest referring symptoms of patients with lung cancer are breathlessness (55%), cough (41%), haemoptysis (22%), chest/shoulder pain (39%) and weight loss (47%). (19) The symptoms are nonspecific therefore the most sensitive method to identify lung cancer cases is an assessment of combinations of symptoms and baseline risk factors.

It is notable that approximately 35% of patients that are diagnosed with lung cancer present as an emergency. (20) This is one of the highest emergency presentation rates in the UK out of all cancers. (20) These patients tend to be older and have a more advanced stage of disease. (21) Hence there is a direct correlation with a lower one-year survival of about 13% in this subgroup of patients. (21) Lung cancer is curable if found at an earlier stage hence there has been a focus on prevention and ways to detect lung cancer earlier which will be discussed in the following section.

### 1.4.1 Prevention and early detection initiatives

In terms of prevention, the single most important measure that has been shown to have the greatest impact on lung cancer incidence is reducing smoking prevalence. This is highlighted by the government in the White Paper, "Smoking Kills" in 1999. (22) It recommended implementation of an advertising ban on tobacco and the creation of NHS smoking cessation services. The format of these services includes regular meetings with a trained advisor that uses withdrawal orientated behavioural therapy as well as smoking cessation medications such as Nicotine Replacement Therapy (NRT), Bupropion or Varenicline. These NHS stop

smoking services have been shown to be effective in supporting smokers motivated to quit in the short and longer term. (23) The UK is the only country in the world to have a cessation service, free at the point of access. Despite the effectiveness of the service and direct proven public health benefits, local funding has been decreasing since 2016.

Achieving an earlier diagnosis through public health campaigns was a key aim of the government in the "Improving Outcomes: A strategy for cancer" document published in 2011. (24) The "Be Clear on Cancer" programme for lung cancer was delivered in 2011. (25) It consisted of national and regional media advertising campaigns and events. The evaluation of the campaign revealed an estimated 700 additional lung cancers were diagnosed compared to the same period the previous year. (25) The success of such campaigns to reduce variation in lung cancer outcomes is clear. However, continued investment on awareness raising initiatives is required to sustain this change.

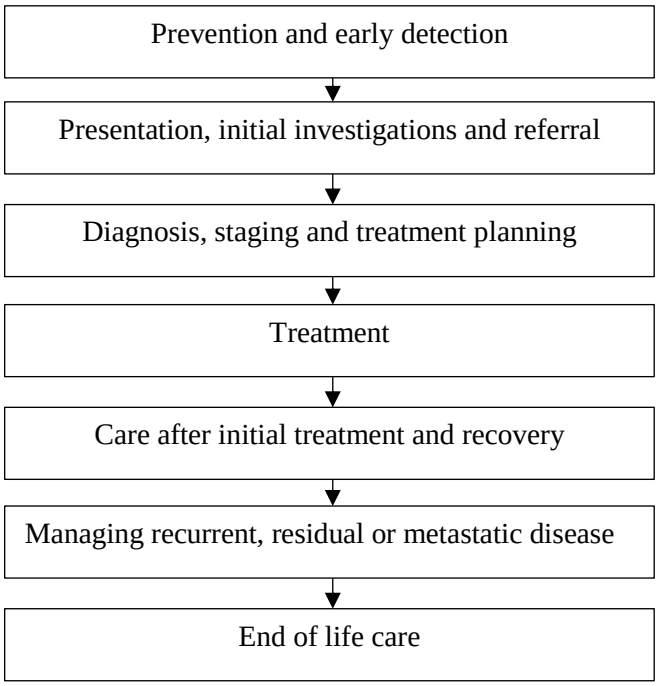
Another method of improving early diagnosis and outcomes for patients is through the adoption of a national screening programme. Results from the US National Lung Screening Trial (NLST) led to the implementation of a national low dose CT screening programme in USA and Canada in 2013. Pilot programmes of low dose CT lung cancer screening have been running in the UK but a national screening programme as not been implemented The ongoing NELSON (Nederlands Leuvens Longkander Screenings Onderzoek) Dutch-Belgian Randomised Lung Cancer Screening Trial results add weight to the mounting evidence in favour of low dose CT screening for individuals at high risk of developing lung cancer in Europe. This randomised controlled trial reports that at year ten, the lung cancer mortality rate ratio in the screened arm versus the unscreened group was 0.74 (26% reduction, p=0.0003) for men and 0.61 (39% reduction, p=0.0054) for women. (26) In addition, pilot studies such as the Lung Screen Uptake Trial (LSUT) and the Manchester Health Check Pilot have

explored how a screening programme could be implemented in the UK. (27,28) Currently, The UK National Screening Committee (UKNSC) does not recommend lung cancer screening due to concerns about the benefits and cost effectiveness of such a programme. (29) Information about gaps in the lung cancer service infrastructure will be essential in establishing whether screening has the potential to be successfully implemented in the UK.

## 1.5 Investigations and Diagnostic Procedures

The diagnosis and assessment of a patient with suspected lung cancer is complex. The optimal pathway to achieving this is described by the NICE guidelines ("The diagnosis and treatment of lung cancer") and the "National Optimal Lung Cancer Pathway" document produced by the NHS England Lung Clinical Expert Group in 2017. There are two main aims of this pathway. Firstly, to obtain maximal diagnostic and staging information with least risk to the patient and secondly, to assess the patient's fitness to formulate an appropriate management plan. Figure 1.4 is a flowchart of the basic clinical pathway.

**Figure 1.4 The lung cancer clinical pathway**




Patients are initially seen by a member of the lung cancer team where a history and physical examination is performed. This will include an assessment of the individuals' fitness according to their performance status. The Eastern Co-operative Oncology Group (ECOG) performance status is assessment of a patients' fitness and summarised in Table 1.2. (30) This grading is used to inform the choice of subsequent investigations in a multidisciplinary team (MDT) meeting. Figure 1.5 shows the stage distribution of cases in England according to performance status. The commonly used investigation modalities used to achieve the pathway aims are summarised in Tables 1.3-1.5.

**Table 1.2 The Eastern Co-operative Oncology Group (ECOG) performance status**

| Score | Description |
|---|---|
| 0 | Fully active, able to carry on all pre-disease performance without restriction |
| 1 | Restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature e.g. light housework, office work |
| 2 | Ambulatory and capable of all self-care but unable to carry out any work activities. Up and about more than 50% of waking hours |
| 3 | Capable of only limited self-care, confined to bed or chair more than 50% of waking hours |
| 4 | Completely disabled. Cannot carry out self-care. Totally confined to bed or chair |
| 5 | Dead |

**Figure 1.5 Performance status (PS) distribution of patients diagnosed with lung cancer in England/Wales in 2016 (4)**

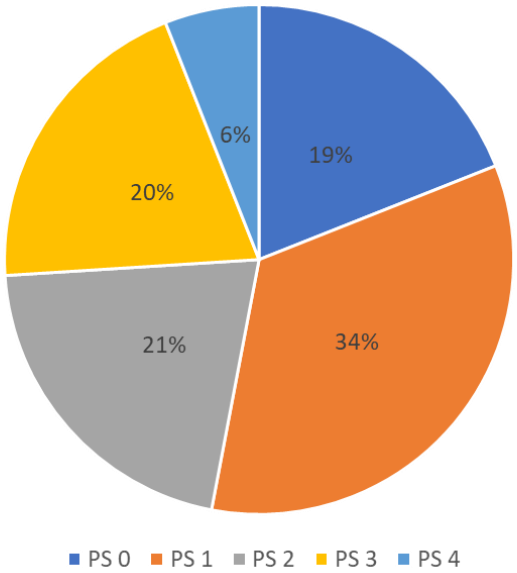


**Table 1.3 Investigations used for staging**

| Procedure | Description | Benefits/Advantages | Risks/Disadvantages |
|---|---|---|---|
| CT scan | A scan that uses x-rays to create detailed images of the body | Quick and accurate | Radiation exposure<br>Harm to unborn babies if pregnant<br>Reactions to contrast material |
| PET- CT scan | An imaging technique that uses radioactive tracers to measure cell metabolism. | Gives unique information on function and structure of the disease<br>Can detect early disease<br>Scans the whole-body allowing identification of potentially affected regional lymph nodes and distant sites. | Radiation exposure<br>Allergic reaction to radioactive material<br>Other factors can affect interpretation of the result<br>Time consuming and expensive<br>Not all units have on site access |

**Table 1.4: Investigations used for gaining a histological diagnosis**

| Procedure | Description | Benefits/Advantages | Significant risks/Disadvantages |
|---|---|---|---|
| Bronchoscopy | Using an endoscopy to visualise the airways and take biopsies | Can be done under local anaesthetic (LA)<br>Day case | Bleeding<br>Infection<br>Pneumothorax<br>Irritation of airways or vocal cords<br>Complications associated with the sedation |
| Endobronchial ultrasound (EBUS) | Using a bronchoscope and ultrasound to visualise and sample the airway wall and surrounding structures (e.g. lymph nodes). | Can diagnose and stage lung cancer at the same time.<br>Can be done under LA as a day case | As above |
| Transthoracic needle biopsy | A biopsy is obtained by inserting a needle under direct image guidance (Ultrasound/CT) under LA | Day case<br>Quick | Dependent on site of biopsy. If lung:<br>Pneumothorax, internal bleeding and air embolism |
| Pleural aspiration | Removal of pleural fluid for investigation. | Simple procedure that can be performed in clinic/by the bedside<br>Sensitivity: 60% in malignancy (31) | Bleeding<br>Infection<br>Organ puncture |
| Thoracoscopy | A camera is inserted to visualise the pleural cavity. This can be done under local (LAT) or general anaesthetic (VAT). | LAT: Direct of visualisation of pleura.<br>Sensitivity 92.6% for malignancy. (32)<br>Diagnostic and therapeutic benefits | Empyema<br>Haemorrhage<br>Port tumour growth |

| | | | |
|---|---|---|---|
| | | VAT: as above with the benefits of being able to biopsy the mass directly, investigate for invasion and perform a surgical procedure to manage the cancer. | Bronchopleural fistula<br>Postoperative pneumothorax/pneumonia<br>Risk of anaesthetic (VAT)/sedation (LAT) |
| Mediastinoscopy | A camera is inserted via the neck to examine and take biopsies from the mediastinum. | Allows accurate staging of the mediastinum with the ability to remove whole lymph nodes | Bleeding<br>Infection<br>Pneumothorax<br>Organ perforation<br>Temporary or permanent paralysis of the laryngeal nerve. |

**Table 1.5 Investigations used for assessment of fitness**

| **Procedure** | **Description** |
|---|---|
| Spirometry | A physiological test to determine how well the lungs are functioning |
| Cardiopulmonary exercise testing (CPET) | A test to determine how well the heart and lungs perform under exercise |
| ECHO | An ultrasound scan that examines the structure and function of the heart and surrounding vessels. |
| Shuttle walk test | Examines an individuals' functional capacity by assessing how far and fast they can walk. |

## 1.6 Management

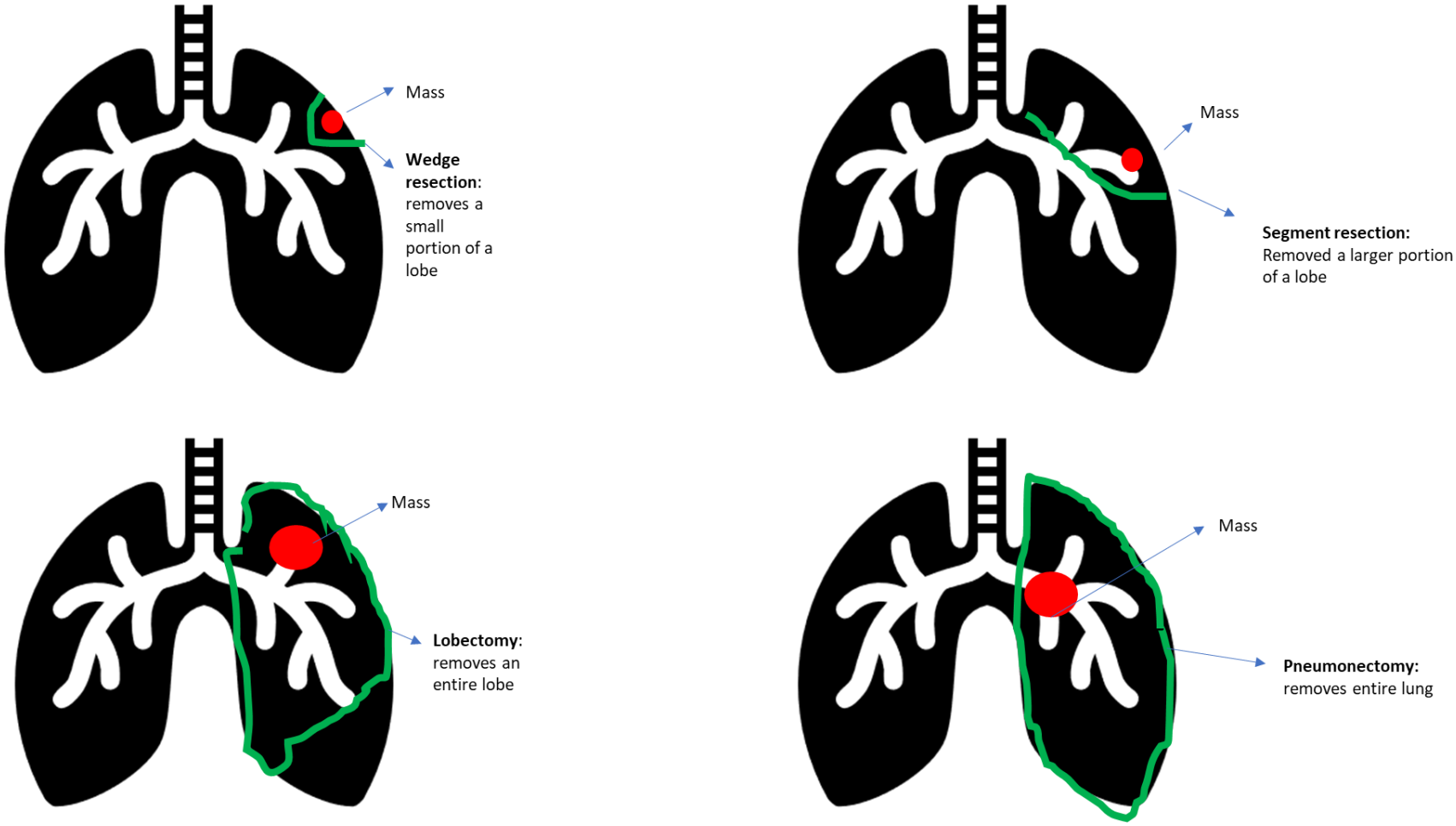
Lung cancer treatment is determined by stage, cell type, fitness and patient preference. The main modalities are surgery, radiotherapy, chemotherapy, immunotherapy and supportive care. The MDT considers the most appropriate choice of treatments that can be offered which fulfils the aims of improving quality of life and survival.

### 1.6.1 Surgery

Surgical resection offers patients the best chance of cure for patients with NSCLC and early stage SCLC. Survival after surgery is estimated as high as 98% at 30 days. (3) In the latest NLCA audit, 17% of non-small cell lung cancer patients received surgical treatment. (4)

The suitability of surgical management of a patients' cancer is dependent on the likelihood of complete removal of the cancer as well as the patients' fitness. The types of surgery that can be performed include a wedge resection, lobectomy, pneumonectomy or sleeve resection; these are illustrated diagrammatically in Figure 1.6. If lymph nodes are affected, then a more extensive procedure is required. The use of minimally invasive techniques such as video assisted thorascopic surgery (VATS) have meant that patients that may have previously been unsuitable for open surgery can benefit from a surgical approach. This technique uses videoscopic guidance through a 4-8cm incision site and two port incisions without the use of rib spreading. (33) Meta-analyses examining outcomes for VATS compared with an open thoracotomy approach demonstrate reduced overall systemic recurrence rate, reduced perioperative complication rates and an improved five-year survival rate with VATS. (34,35)

**Figure 1.6 Surgical procedures performed for lung cancer**



### 1.6.2 Radiotherapy

Radiotherapy has an established role in the treatment of lung cancer. It can be given with curative intent in early inoperable and locally advanced NSCLC as well as in the adjuvant treatment of limited SCLC. In addition, it is used in the palliation of all types of lung cancer. (36)

Radiotherapy delivered by Stereotactic Ablative Body Radiotherapy (SABR) is now established as the standard of care for patients with inoperable peripheral early stage NSCLC. This technique delivers higher doses of radiation compared to conventional radiotherapy avoiding surrounding healthy tissue facilitated by 3-dimensional computed tomography (3DCT). Beams from different angles are shaped precisely to target the tumour. (36) The precision of this technique coupled with the use of patient immobilisation to minimise movement during delivery leads to minimal treatment related toxicities. The use of SABR for operable patients is controversial. (37) A pooled analysis of two randomised controlled trials of operable patients with early stage NSCLC showed that the three-year survival was higher with SABR by 16% compared to surgery ($p=0.037$). (38) In addition, a propensity score matched analysis found decreased rates of severe toxicity with SABR compared to a lobectomy performed by VATS for early stage NSCLC. (39) However, a recent meta-analysis ($n=13,598$) showed SABR was associated with a lower three year overall survival ($p=0.001$) and an increased hazard ratio for all-cause mortality ($p<0.001$). (40) Consequently, poorly examined factors such as quality of life and patient experience are relevant for patients to make informed treatment decisions.

In patients with early stage NSCLC where SABR is contraindicated, conventional fractionated radical radiotherapy can be offered as 55 Gray (Gy) in 20 fractions over four weeks or 60-66 Gy in 30-33 fractions over 6-6 ½ weeks. (41)

Radiotherapy delivered in locally advanced NSCLC (stage III) is also a challenging area of management. At one end of the spectrum of this diverse stage are surgical patients identified with pathologically confirmed N2 disease (spread to the ipsilateral mediastinum) where the recently updated National Institute of Clinical Excellence (NICE) lung cancer guidance (March 2019) recommends tri-modality therapy with surgery, chemotherapy and radiotherapy. (41) Whereas at the other end are patients presenting with bulky mediastinal nodal disease where concurrent chemoradiotherapy is advised with the addition of the immunotherapy agent Durvalumab as recommended by the new NICE technology appraisal. (42)

The role of thoracic adjuvant radiation and prophylactic cranial irradiation in the curative management of limited stage SCLC is well established. (43) Two meta-analyses have demonstrated that combining chemotherapy with thoracic radiotherapy significantly decreases local relapse and improves overall survival in patients with limited SCLC. (44,45) In addition, several studies show that the delivery of concurrent therapy compared to sequential treatment leads to better disease control. (46,47) However, the optimum dose and timing of such treatments and the use of thoracic radiation therapy in extensive disease is subject to ongoing research.

Approximately 45% of patients who achieve a complete response to initial treatment for SCLC with chemoradiotherapy will present with central nervous system (CNS) metastases as the only site of recurrence at two years. (48) It is estimated that the delivery of prophylactic

radiotherapy to the CNS has reduced the incidence of brain metastases by 52-54% with a survival improvement of 16-18% in patients with a good performance status who have achieved a complete response to initial treatment. (49,50) However, the optimal dose of each fraction is still unknown.

When curative intent treatment is inappropriate, radiotherapy delivered at palliative doses is shown to effectively manage symptoms. (36) One study reported an improvement in performance status in 73% of patients with the median duration of palliation from 28%-57% of patient survival. (51) Additionally, Langendijk et al show improvement in the following symptoms: haemoptysis (79%), pain and cough (50%) dyspnoea (40%), fatigue (22%) and anorexia in 11%. (52)

The clinical benefits of radiation treatment must be carefully balanced against potential toxicities to surrounding healthy tissue which has been reported to occur in up to 37% of irradiated patients. (53) The risk has been shown to be related to performance status, underlying lung function, lung volume being exposed, radiotherapy dose and the addition of chemotherapy. (53) The advent of new technologies in treatment planning and delivery, such as Intensity Modulated Radiotherapy (IMRT) mean that optimal doses of radiation can be delivered with minimal toxicity. (54) However, further knowledge is required on optimal patient selection to further improve patient outcomes through the application of such innovations.

### 1.6.3 Systemic therapies

The cornerstone of treatment for SCLC is platinum-based combination chemotherapy. This is optimally delivered concurrently with radiotherapy in curative intent treatment for limited

stage disease (as described in section 1.6.2) and with palliative intent in extensive disease. In the latter a regimen of Cisplatin or Carboplatin plus Etoposide for up to six cycles followed by active surveillance has been shown to achieve responses of up to 75% with an acceptable toxicity profile. (55)

In NSCLC, chemotherapy is beneficial for palliation in stage III-IV disease or part of curative intent multi-modality treatment in locally advanced disease. In the palliative setting, the goal of treatment is to improve survival and reduce disease related adverse events.

Up until recently the only option for patients with advanced lung cancer was chemotherapy. Over recent years the use of medicines targeted at genetic mutations (epidermal growth factor receptor (EGFR), anaplastic lymphoma kinase (ALK) and ROS proto oncogene 1 (ROS-1)) in a patients' cancer has become a key part of the future for patients with lung cancer, particularly as these newer treatments are better tolerated by patients than standard chemotherapy. The first genetically targeted treatment for NSCLC was gefitinib, an oral treatment targeting the EGFR signally pathway depicted in Figure 1.2. Abnormal activation of this pathway through genetic mutations of the receptor leads to prevention of apoptosis, uncontrolled proliferation and metastasis of tumour cells. (56) EGFR tyrosine kinase inhibitors function on the principle that EGFR's possess an intracellular tyrosine kinase domain with an ATP-binding cleft. (56) If this cleft can be blocked chemically, the receptor efficacy is decreased – hence reducing the oncogenic processes it facilitates. (56) Oncogenic driver mutations account for approximately one quarter of lung adenocarcinoma cases and are targetable with approved drugs. (57) Clinical trials have demonstrated improved progression free survival with targeted therapy compared to chemotherapy. (58–60)

The newest class of systemic treatments are immune checkpoint inhibitors (pembrolizumab, nivolumab and atezolizumab). These act on the programmed death ligand 1 or 2 (PD-L1 and PD-L2) and programmed death 1 (PD-1) receptor pathway. PDL-1 proteins supress the immune system by binding to PDL-1 receptors on cytotoxic T cells. Some cancer cells express PD-L1/2. Inhibitors prevent protection of cancer cells from the immune system and allow cancer cells to be identified and undergo cytotoxic T cell mediated death. The KEYNOTE-010 trial demonstrated that pembrolizumab significantly improved overall survival compared to standard chemotherapy in people with previously treated NSCLC who had >1% expression of PD-L1 tumour cells. (61) Similar findings have been seen with Nicolumab as well. (62) In addition, significant improvements in overall survival have been demonstrated with patients with >50% expression of PD-L1 and no driver mutations compared to being treated with chemotherapy. (63)

The updated NICE guidelines present the large number of currently approved systemic therapy options for people with Stage IIIB-IV NSCLC summarised in Table 1.6. (41)

**Table 1.6 NICE recommended first line Systemic anti-cancer management options for people with Non-Small Cell Lung Cancer (NSCLC)** (41)

| **Treatment Agent** | **Key trial/s** | **Comparator** | **Results** |
|---|---|---|---|
| **Non-squamous/NSCLC (non-otherwise specified)** | | | |
| ***EGFR-TK positive*** | | | |
| Afatinib | LUX lung 3/LUX lung 6 (64) | Platinum doublet chemotherapy | Increased overall survival, p=0.00015 (LUX Lung 3); p=0.023 (LUX Lung 6) |
| Erlotinib | EURTAC(65)/OPTIMAL (66) | Platinum doublet chemotherapy | Improved PFS p<0.001 (EURTAC); p<0.0001 (OPTIMAL) |
| Gefitinib | IPASS (67) | Platinum doublet chemotherapy | Improved ORR (p=0.004) |
| ***ALK positive*** | | | |
| Ceritinib | ASCEND-4 (68) | Platinum doublet chemotherapy | Improved survival, p<0.0001 |
| Alectinib | ALEX (69) | Crizotinib | Improved survival and disease-free progression, p<0.001 |
| Crizotinib | PROFILE 101 (70) | Platinum doublet chemotherapy | Improved survival and PFS, p<0.001 |
| ***ROS-1 positive*** | | | |
| Crizotinib | PROFILE 1001 (71) | Single arm study | ORR: 70% (95% CI 56-82%); Median PFS: 19.3 months (95% CI 14.8-NR) |
| ***No gene mutation or fusion protein*** | | | |
| ***PD-L1 <50%*** | | | |
| Pembrolizumab and platinum doublet chemotherapy | KEYNOTE-189(72) | Platinum doublet chemotherapy and placebo | Improved survival, p<0.008 |
| Platinum doublet chemotherapy | (48,73–75) | Supportive care/Single agent | Improved one-year survival, p<0.001; |

| | | | |
|---|---|---|---|
| | | chemotherapy/non platinum based treatment | Reduction in overall mortality/improved PFS<br>Improved response rate and overall prolongation of survival |
| ***PD-L1>50%*** | | | |
| Pembrolizumab and platinum doublet chemotherapy | KEYNOTE-189(72) | Platinum doublet chemotherapy and placebo | Improved survival, $p<0.008$ |
| Pembrolizumab | KEYNOTE-024(73) | Platinum doublet chemotherapy | Improved survival, $p<0.05$ |
| **Advanced Squamous cell carcinoma** | | | |
| ***PD-L1<50%*** | | | |
| Platinum doublet chemotherapy | Several | Single agent chemotherapy/non platinum based treatment | Improved survival, $p<0.05$ |
| ***PD-L1>50%*** | | | |
| Pembrolizumab | KEYNOTE-024(73) | Platinum doublet chemotherapy | Improved survival, $p<0.05$ |

ORR: Odd rate ratio; PFS: Progression free survival; NR: Not reported

Innovations in this area are occurring at an impressive rate for patients with metastatic NSCLC as well as those with earlier stage disease and in combination with other therapies. Durvalumab, a monoclonal antibody directed against PD-L1, significantly improves progression free survival in addition to chemoradiotherapy in stage III NSCLC. (76) Clinical trials are ongoing investigating such novel therapies as monotherapies and in combination with other treatments in diverse stages of the disease and are likely to offer further treatment options for patients in the future.

### 1.6.5 Supportive care

Adequate control of symptoms to improve quality of life is crucial for patients with lung cancer, particularly as over half of patients present with an advanced stage (stage IV). (4) In addition to the palliative radiotherapy treatments described above, other treatments are available to control specific symptoms. These include endobronchial tumour treatment for airway obstruction (brachytherapy, electrocautery, laser ablation, cryotherapy, stent insertion and photodynamic therapy), pleural procedures for fluid drainage via tube insertion or placement of an indwelling catheter, and supportive care with specialist palliative care input.

Temel et al demonstrated the importance of specialist palliative care support in lung cancer care by examining the effect of early specialist palliative care support compared with standard care in ambulatory patients with metastatic NSCLC referred to the medical oncology outpatient department.(77) They showed a significant difference in median survival in the specialist care support group compared with standard care (11.6 months vs 8.9 months). These patients also had a better quality of life scare and fewer depressive symptoms and were less likely to require aggressive end of life care support.

## 1.7 The organisation of lung cancer services in the UK

Lung cancer services in the NHS are commissioned locally by clinical commissioning groups (CCG's), with specialist services (chemotherapy, radiotherapy and thoracic surgery) being commissioned directly by NHS England.

The Cancer Taskforce recommended the formation of cancer alliances with the aim of offering flexibility to best serve local communities. Each alliance has an Expert Advisory Group (EAG) covering lung cancer that is made up of clinicians across the network who specialise in thoracic oncology. (11)

The aim of a local commissioning structure is to allow providers to implement cancer services based on their knowledge of the local situation. However, it also has the potential to increase variation in access to services. The implementation of several national standards aims to standardise care. These include the Care Quality Commission (CQC) care standards, cancer surveillance quality indicators as well as speciality specific guidelines such as Royal College of Pathologists guidelines. In addition, lung cancer services are required to adhere to NICE guidelines target of a definitive diagnosis by 28 days and 62 days from referral to first treatment.

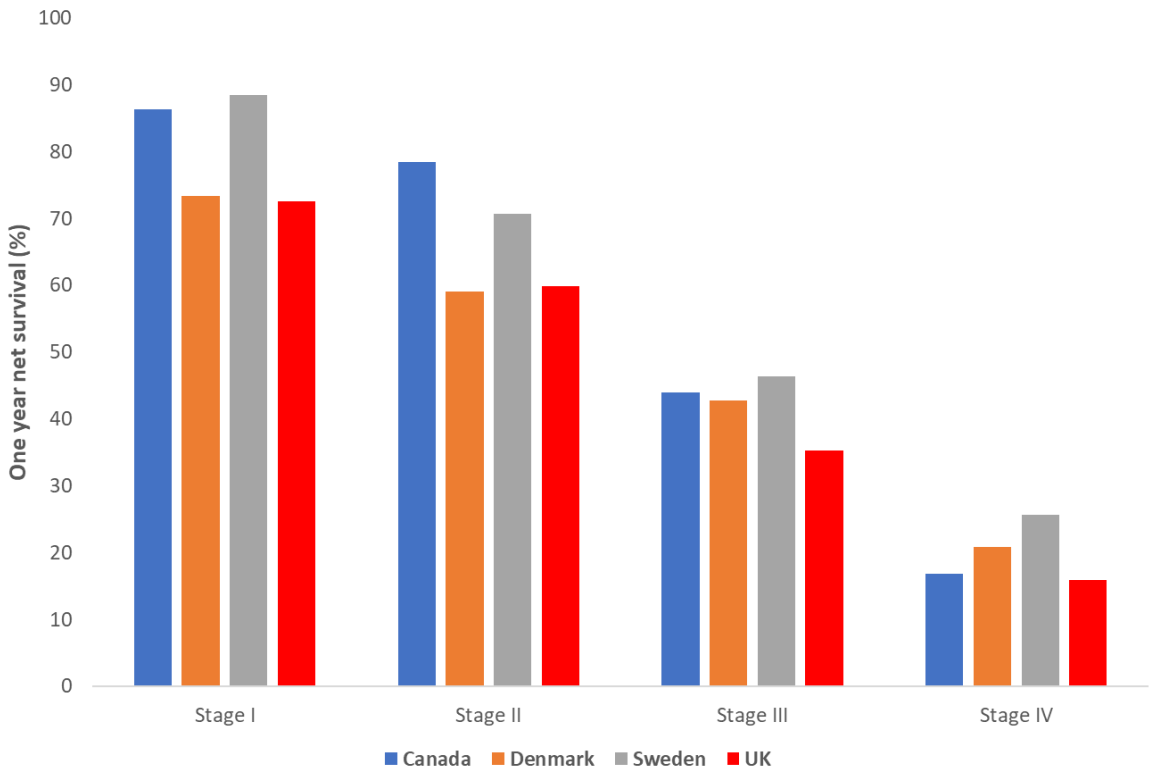
The above standards aim to reduce variation in care across the country. However, each case presents in a unique manner and management should be considered on an individual basis. To ensure that appropriate care is considered in all patients the NHS cancer plan in England and the Cameron report in Wales recommend cancer multidisciplinary team (MDT) meetings to discuss all lung cancer cases. (11) There are 156 MDTs in England and Wales.

### 1.7.1 Understanding variation in lung cancer care

Survival rates for lung cancer in the UK consistently lag behind other benchmarked countries. A European cancer registry based study (EUROCARE project) reported a five year survival of 9.72% in the UK and Ireland compared to 13.4% in central Europe for adults diagnosed between 2000 and 2002. (78) More recently, a study comparing lung cancer survival in six

developed countries between 2004 and 2007 found the age standardised one-year survival from NSCLC ranged from 30% in the UK to 46% in Sweden. Additionally, England fared worse than other countries in this study even after stratifying for stage as seen in Figure 1.7. These results are a cause for concern and it is estimated that at least 1300 lives could be saved per year if survival rates were as good as the best in Europe. (79)

**Figure 1.7 Age standardised one-year net survival from NSCLC by stage at diagnosis** (80)




Some of the international variation seen in the aforementioned study may be due to differences in the collection and presentation of data. For example, ten of the countries involved in the EUROCARE project only used regional registries which do not represent the whole of the population. In addition., some national cancer registries (such as the

Scandinavian registries) do capture the whole population but do not include death certificate information. However, the consistency of international comparisons suggest that there are other contributory factors. (81) Firstly, national audit data from England and Wales show that over two thirds of patients present at an advanced stage. (82) Studies investigating reasons for this sugest that there is a delay in patients seeking attention from their GP from the onset of their symptoms. Additionally from the point of referral, delays in pathway speed in secondary care have been related to poor outcomes. (83)

Secondly, understanding the characteristics of the population, such as the co-morbidities and performance status, is crucial in survival comparisons as they are key determinants of treatment choice and outcomes. However, even after accounting for case mix, there is still significant variation in outcomes. For example, the latest national lung cancer audit report showed that one year survival varies across various organisations from 27% to 49% after accounting for case mjx. (17) This suggests that differences in management of patients may contribute to such variation. This is demonstrated by the audit finding that in 2017, the curative intent treatment rate for patients with early stage NSCLC and a good performance status varied across organisations in England from 50% to 100%. (84)

Finally, it has additionally been hypothesised that the organisation of lung cancer services impacts UK survival rates. (85) Preliminary analysis of the NLCA organisational audit found that patients seen in trusts in England with the following onsite facilities were more likely to have surgery after accounting for case mix: PET scan (OR 1.2, 95% CI 1.01-1.41), stereotactic radiotherapy (OR 1.55, 95% CI 1.26-1.92) or video assisted thoracoscopy (VAT) lobectomy (OR 1.28, 95% CI 1.06-1.56).

### 1.7.2 Initiatives to improve provision of lung cancer services

In response to the need to improve national lung cancer outcomes, several initiatives have been established.

The National Optimal Pathway is designed to improve local lung cancer organisation of services with the aim of achieving a faster pathway and better patient outcomes. (86) It provides clear guidance for commissioners such as the adoption of the following key features:

i.) CXR to CT and clinic in less than 24 hours

ii.) Rapid turnaround times for testing and reporting

iii.) Daily respiratory clinic opportunities and

iv.) Direct to biopsy option.

A document that provides commissioning advice accompanies this pathway. This document recommends a list of resource metrics that can be used to benchmark a service. The widespread implementation of this pathway along with the commissioning guidelines is awaited. However, there is evidence that faster pathways influence patient outcome but robust evidence to underpin the recommendations in the commissioning guidance is lacking. (11,87–89)

### 1.7.3 Using population-based data to improve patient outcomes

Local and national initiatives that change the organisation of lung cancer care have the potential to improve patient outcomes. However, good quality national data are required to

accurately assess the impact such programmes have on lung cancer outcomes. The analysis of this data is vital in informing service development.

In the UK, data collection is carried out by The National Cancer Registration and Analysis Service (part of PHE) and the National Lung Cancer Audit group (part of the Royal College of Physicians (RCP)).

The National Lung Cancer Audit (NLCA) was developed in response to the finding in the late 1990's that outcomes for lung cancer patient in the UK lag behind those in other westernised countries and varied considerably between organisations. The NLCA attempts to address this performance gap by: i) the establishment of challenging standards for lung cancer management and ii) the collection of detailed data on lung cancer management and assessment of individual lung cancer units against these standards. The audit began collecting national data in 2005 and it is the largest, most detailed lung cancer dataset in the world. The dataset has been shown to be unbiased and representative of lung cancer patients in England. (90) It currently forms part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP) commissioned by the Healthcare Quality Improvement Partnership (HQIP). The data has been used to underpin National Institute for Health and Care Excellence (NICE) guidelines and guide national service improvement projects. Locally, it drives quality improvement programmes and opens discussions with health managers/commissioners.

## 1.8 Conclusion

For the last ten years, lung cancer is the biggest cause of cancer death in the UK. Despite, advances in diagnostics and therapeutic modalities survival, there has not been much improvement in the last fourty years and consistently lags behind other countries. (91) In addition. audit data shows significant national variation in survival outcomes which can not

be fully explained by patient level features such as age and performance status. Understanding the role of organisational and resource factors in determining lung cancer outcomes is key to understanding this variation and how improvements can be achieved. However, there is little data that examines the organisation of lung cancer services in the UK and robustly links this with patient outcomes; a knowledge gap that requires urgent attention.

National publications have set out key priorities for commissioning patient centred services for people with lung cancer in the UK. This study aims to provide robust evidence to underpin future recommendations for a safe and effective lung cancer service. Commissioning services that are evidenced to achieve the best outcomes would result in a significant improvement in survival for people with lung cancer in the UK.

## 1.9 Aims of thesis

The overarching goal of this project is to identify the primary independent factors linking lung cancer management to outcomes. Defining these factors both locally and nationally will be critical in guiding policy and recommendations about the minimum resources required for a hospital to deliver a safe and effective lung cancer service. A chapter outline is described below

### 1.9.1 Aim 1: Determine the optimum structure for cancer services in England

Chapter 2: The impact of organisation of care on patient outcomes in lung cancer: A systematic review.

The objective of the first chapter is to report the current published evidence linking lung cancer service delivery interventions and patient outcomes by standard systematic review methodology. The aim is to identify the effectiveness and challenges of such interventions and generate a set of factors to benchmark services.

### 1.9.2 Aim 2: Establish national variation of lung cancer services and explore the impact of specialist service delivery on lung cancer outcomes.

Chapter 3: The second National Lung Cancer Organisational Audit: results and impact of organisation and specialist service delivery on lung cancer outcomes.

This chapter describes the results of the second NLCA organisational audit performed in 2016 and links the results with patient related data. This was done using the NLCA and associated datasets. There are three main objectives of the chapter. Firstly, to describe the national provision of diagnostic and treatment modalities. Secondly, to ascertain an accurate picture of speciality staffing provision in lung cancer units in England/Wales. Thirdly to identify primary independent factors linking lung cancer management to patient outcomes. The objectives were in part determined by the results from the systematic review.

### 1.9.3 Aim 3: Investigate the uptake of treatment regimens and the corresponding survival outcomes for patients with Stage III NSCLC in England and examine the impact of hospital infrastructure on patient outcomes in this stage.

Chapter 4: Management of Stage III NSCLC in England

In this chapter, treatment patterns and outcomes for stage III NSCLC patients in England are presented and are benchmarked against results from international population-based studies. The management of this diverse stage is complex and controversial reflected in international variability in treatment patterns and outcomes. (92) Therefore this stage was chosen to fill the knowledge gap between clinical trial data and clinical practice in the UK.

### 1.9.4 Aim 4: Critically examine the process of local decision making with a focus on the MDT meeting in one hospital trust.

Chapter 5: Decision making in lung cancer: A local qualitative study

The variability of care across the country, even in areas where the classical evidence base is relatively clear, suggests that organisational factors not typically measured or reported in population-based studies might be impacting on choices made by MDT's. The objective of the final results chapter is to describe these factors. This study investigates organisational and patient factors that influence decision making in lung cancer using qualitative methodology. The objective of this analysis is to provide multi-disciplinary recommendations to optimise the efficiency and effectiveness of a local lung cancer service organisation.

# CHAPTER 2 THE IMPACT OF ORGANISATION OF CARE ON PATIENT OUTCOMES IN LUNG CANCER: A SYSTEMATIC REVIEW

## 2.1 Introduction

It is likely that the way health systems are organised contribute to patient outcomes; an aspect of healthcare that has been poorly investigated. (85) The following section discusses the importance of health systems research, gaps in the existing research and challenges to conducting such research.

### 2.1.1 The importance of health systems research in lung cancer

A working paper published by the World Health Organisation in 2012 recognised that health systems research is essential for achieving better worldwide health status. (93) The report estimates that two thirds of child mortality and three quarters of maternal mortality could potentially be eliminated if research on the effective implementation of existing interventions was completed. (93)

Several initiatives in the UK, have been established to improve the delivery of lung cancer services, such as the "Independent Cancer Taskforce" and the lung cancer commissioning guidance. (11,94) Yet, little is known about how these strategies impact patients. The identification of best practice models that have been evidenced to improve outcomes for patients is vital for the patient, provider and health system.

For the patient, the identification of key organisational determinants of healthcare has the potential to reduce unwarranted national variation in care and consequently improve survival rates, symptom control and patient experience. For health care providers, awareness of models that have been shown to benefit patients is essential in ensuring the hospital infrastructure is sufficiently resourced. Not only does timely care confer benefit to the patient but also financial savings mean there are benefits to the health system as well

### 2.1.2 Gaps in the existing lung cancer literature

A European taskforce report investigating the quality of management in lung cancer care concluded that there is little research activity involving quality improvement in lung cancer. (95) They report that lives could be saved if models of healthcare evidenced to improve patient outcomes are applied to health systems. (95) However, robust information collating this information is sparse and reviews that have been published have generally examined only a single process of the lung cancer pathway such as timeliness of care or multidisciplinary aspects of lung cancer management. (96,97) Lung cancer patients require a co-ordinated and connected approach for optimal care, therefore a co-ordinated approach to research is also needed. A robust systematic synthesis of lung cancer health service delivery interventions is crucial in achieving this.

In 2007, the Australian government published a review of models of best practice approaches to lung cancer care to inform future quality improvement activities. (98) They found the following important aspects of service delivery 1.) Involvement of an MDT 2.) Involvement of a specialist medical practitioner in diagnosis and treatment 3.) Care co-ordination including the role of nurse navigators/care co-ordinators 4.) Early integration of palliative care 5.) Consideration of supportive and quality of life needs and finally 6.) The involvement of

primary/community-based care. (98) Though this review provides a useful summary of the literature, the majority of the included studies examined data from nearly thirty years ago and several important changes to the practice of lung cancer care have since occurred. This includes the widespread use of PET scanning for staging, improvements in EBUS techniques, and novel therapeutic options e.g. immunotherapy and SABR.

The previously mentioned European taskforce report also conducted a narrative literature search in lung cancer care performance. (95) Similar to the Australian study, they reported benefits to lung cancer patients with multidisciplinary team care, fast track clinics and lung cancer centres. (95) However, both reviews have two main limitations. Firstly, and importantly the impact on patient outcomes is lacking. Several interventions were described but not all associations with patient outcomes were reported. Secondly, systematic methodology was not applied. The Australian report limited their search to one database and neither conducted formal quality assessments. The incorporation of these techniques would enhance knowledge of the subject through increased article capture and precise evaluation of the methodological quality of the included articles.

### 2.1.3 Challenges of conducting systematic reviews in health care service delivery

The majority of published systematic reviews focus on estimating the effectiveness of therapeutic interventions, assessing the accuracy of diagnostic tests or quantifying epidemiological relationships. (99) Despite increasing interest in reviews concerning the organisation of healthcare, they are not as commonplace. Moreover, there is little guidance detailing optimal methodology. (99)

Challenges in conducting health system reviews contribute to this disparity. According to the Cooper model of research synthesis there are three stages of evidence synthesis: problem formulation, data collection and analysis with interpretation. (100) Table 2.1 summarises the challenges associated with each of these stages.

**Table 2.1 Challenges with conducting health system systematic reviews**

| **Systematic review stage** | **Issues** |
|---|---|
| Research question formulation and inclusion criteria | - Difficulty in clarifying the boundaries and characteristics of the study subject due to the complex and changing nature of health systems. |
| Data collection | - Lack of expertise and guidance<br>- Relevant health system articles are poorly indexed by MESH terms<br>- Time consuming: several searches are required to be performed and assimilation of background subject knowledge is required to ensure a comprehensive search strategy is performed.<br>- Definitions of key concepts differ between articles |
| Data synthesis and interpretation | - Heterogeneity: studies tend to be heterogenous in study design, reported outcomes and quality.<br>- Lack of standards in reporting and evaluating such studies<br>- Dependent on context limiting generalisability and applicability. |

To address these challenges, a scoping review of the impact of service delivery on patient outcomes was performed with the aim of providing a more robust search strategy for the main review.

### 2.1.4 Rationale of scoping review

The primary aim of the scoping review is to uncover areas for improvement in the main review process. The five main reasons for this are summarised in Table 2.2.

**Table 2.2 Rationale of scoping review**

| Rationale | Description | Example | Reference |
|---|---|---|---|
| Theme identification | The principles of health service design are likely to be generalisable. Therefore, highlighting themes in the general medical literature clarifies the final research question. | Stroke medicine implemented a "door to needle time" for the timely administration of thrombolytic therapy, which led to a decrease in mortality and morbidity Subsequently, infectious diseases recommended a "door to needle time" of one hour for antibiotic administration in severe sepsis, which has also decreased patient mortality | (101–103) |
| The exploration of data bases | Exploration of databases and thesauri optimises the search strategy | Adequate understanding of terms that deliver relevant articles has been shown to improve the final search strategy. | (103) |
| Investigate established theoretical frameworks | Uncovering established models on the subject aids search strategy development | A review on "The Effect of Health Care Working Conditions on Patient Safety" adapted two identified models found in a scoping review describing the major characteristics of work environments to enhance capture in the main review. | (104) |
| Highlight heterogeneity in the research question | Examination of study types and outcomes likely to result from the search demonstrates heterogeneity with the research question. | This has been shown to aid quality assessment and inclusion criteria selection. | (103) |
| Facilitate discussion with the research team | Expertise can be gained from the scoping review in formulating a robust methodology. | Input from multiple specialist sources in a scoping review has shown to increase article capture. | (103) |

To fulfil the described benefits of a scoping review, the remit of the scoping review is broad. This will enable a process of scoping, piloting and refinement that has been previously used successfully. (103) The following section describes the methodology and results of the scoping review. This is followed by a discussion of how the results apply to the main review.

## 2.1.5 A scoping systematic review on the impact of hospital resources and organisation of care on patient outcome

### 2.1.5.1 Methods

Standard systematic review methodology aimed at minimising bias was used, with reference to the Cochrane Handbook for Systematic Reviews of Interventions to identify articles reporting organisation of care interventions associated with patient outcomes. (105)

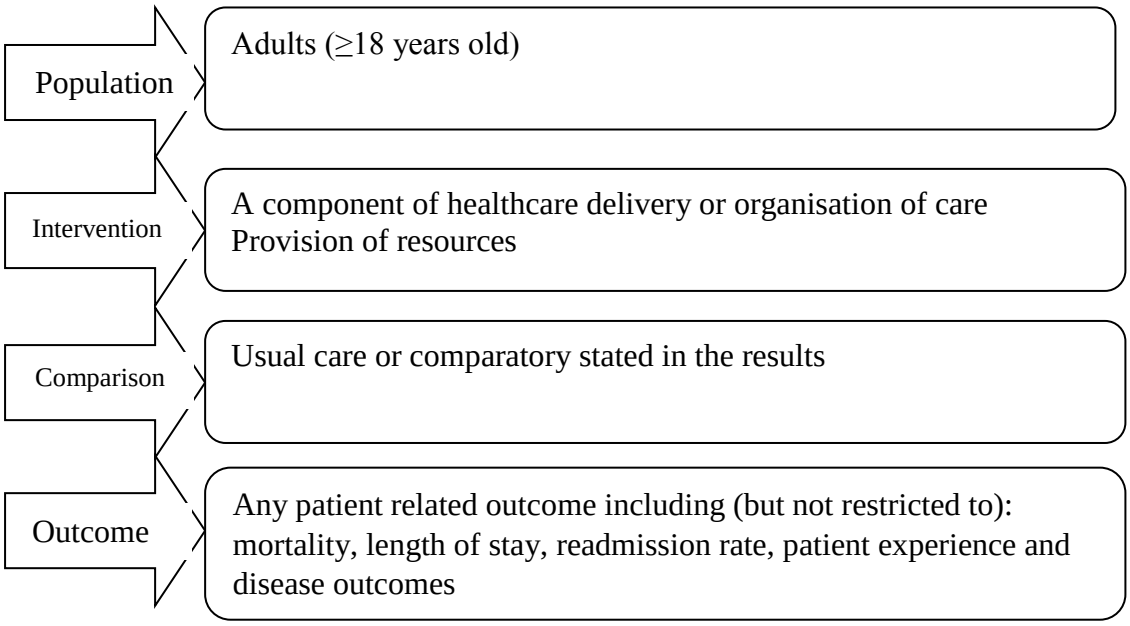
#### *2.1.5.1.1 Search Strategy*

The following databases were searched: MEDLINE (via Ovoid), Cochrane Library (Wiley) CENTRAL and PubMed. No language or date restrictions were applied. The full search strategy is shown in the appendix (A1). Additional studies were identified by review of reference lists of relevant publications and contact with field experts.

#### *2.1.5.1.2 Study selection criteria*

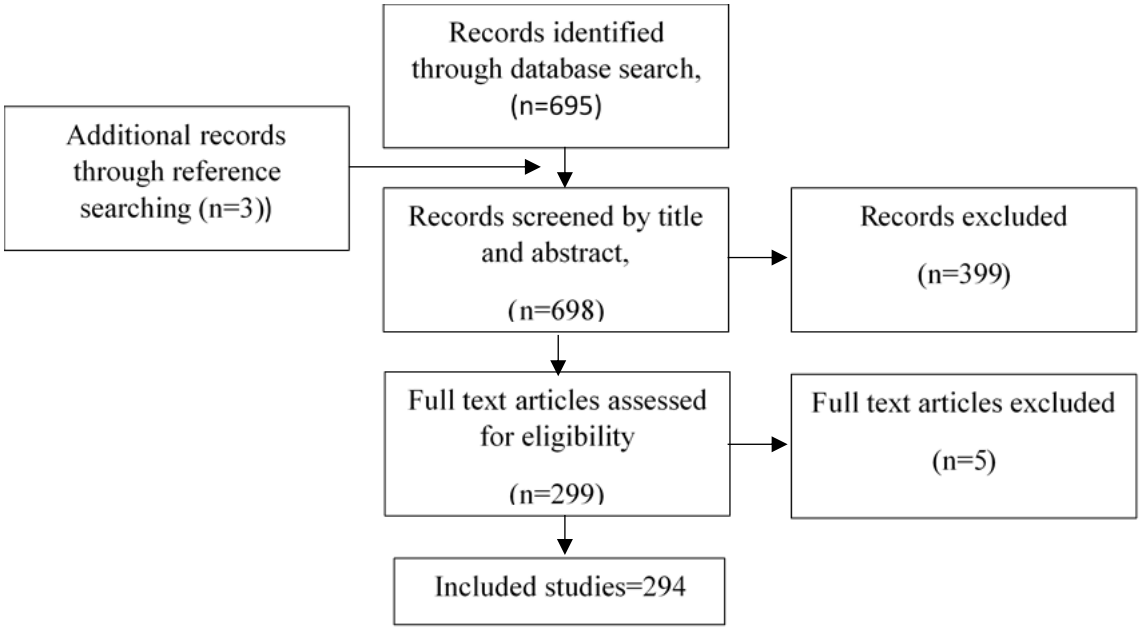
The selection criteria are summarised in Figure 2.1.

**Figure 2.1 PICO chart detailing inclusion criteria for scoping review**




Articles were searched irrespective of clinical condition, patient population or specific outcomes to include a wide base of articles. Interventions conducted either exclusively in an outpatient, inpatient or across settings were included. Also included were other reviews where only a part of the review evaluated an intervention of interest. Studies where education was the main intervention or could not be separated were excluded. Titles and abstracts of studies were retrieved and screened independently by two reviewers (J.A and A.B) to identify studies potentially meeting the inclusion criteria. The full text was retrieved and assessed similarly (J.A and A.B), with any disagreement resolved by discussion. Additionally, the researchers met regularly to discuss specific articles. Figure 2.2 summarises the article selection process.

**Figure 2.2 PRISMA flow diagram for scoping review**




*2.1.5.1.3 Data extraction and assessment of bias*

The primary reviewer (J.A) used a standardised form to extract data including assessment of study quality, quality of evidence synthesis, study setting/population, details of the intervention, study methodology and outcomes. A second reviewer (A.B) checked and validated the extracted information.

The evidence synthesis included a wide range of study designs, including systematic reviews and primary studies. Therefore, a single bias tool was not appropriate. The ROBIS tool was used for systematic reviews and the modified ROBINS I tool for other study designs. (106,107) These tools are discussed in greater detail in section 2.2.5.1.

2.1.5.2 Results

Table 2.3 shows the characteristics of the 294 included studies. A summary of the study outcomes is shown in Table 2.4. Due to heterogeneity of studies in terms of subject area and outcomes, the data was suitable for narrative synthesis only. The following themes were identified: staff workload, specialist care, co-ordination of care, use of technology, home care/day case procedures and clinical pathways/record keeping.

**Table 2.3a Table of characteristics of included observational studies in the scoping review**

| **Author**<br><br>**Date** | **Population Inclusion Criteria** | **Participants** | **Intervention** | **Outcomes** |
|---|---|---|---|---|
| Price<br><br>2003 (108) | Units within the UK admitting medical cases.<br><br>40 consecutive patients admitted with acute COPD cases. | N= 7529<br><br>7986 episodes of care from 234 units.<br><br>Demographics: not published. | Organisational score<br><br>Staffing levels | Inpatient death within 90 days of admission: statistically significantly lower with increased medical staffing at all levels<br><br>Length of stay: significantly decreased with greater number of respiratory consultants, EDS and local guidance on follow-up.<br><br>Readmission within 90 days: nil significant<br><br>Organisational score not significantly associated with any outcome. |
| Ozdemir<br><br>2015 (109) | Patients in UK admitted with a ruptured AAA (ICD codes I713&I718) between 1/04/05-31/03/10 identified by the HES data warehouse. | N=9877<br><br>From 153 trusts<br><br>Mean Age (yrs.): 78<br><br>Sex (male) n (%): 7310 (74) | Staffing, physical hospital structure, use of radiology, teaching status of trust, weekend admission and critical care bed | 90-day mortality: significantly greater (multivariate analysis) with lower: consultant staffing, fluoroscopy use and nursing staffing. Greater if hospital had teaching status.<br><br>Non-corrective treatment: significantly greater (multivariate analysis) with lower consultant staffing, & nursing staffing; hospital status and weekend admission. |
| Roberts<br><br>2003 (108) | All acute hospitals in England and Wales | N= 1274<br><br>From 30 hospitals | Hospital type, staffing, speciality of staff, | Death within 90 days: Significantly greater for less medical staff availability; decreased proportion of physician estimated proportion |

| | | | | |
|---|---|---|---|---|
| | Cases of acute COPD (physician made diagnosis) admitted to hospital identified prospectively over 8 weeks. | Mean age: (yrs): 72.1<br>Sex (male), n (%): 716 (56)<br>Mean FEV1, n, (% predicted): 405 (41%) | availability of NIV. | of patients cared for by respiratory specialists; non-availability of NIV. |
| Jarman 1999 (110) | All NHS hospitals in England.<br>Patient discharged with a primary diagnosis that is one of the diagnoses accounting for 80% of inpatient deaths. In 1991-1992 & 1994-1995. | 183 trusts with 7.7 million admissions.<br>Demographics not included. | Discharge, hospital and community independent variables. Relevant variables include medical and nursing staffing levels, bed availability, teaching status, provision of specialist units. | Hospital standardised mortality ratios: Statistically significantly associated with lower number of doctors per 100 hospital beds, lower number of GP's per 100,000 population, increased reported number of grade A nurses. |
| Hannan<br>1989 (111) | Patients discharged in 1986 from an acute care facility in New York State following a surgical procedure. | N=48139<br>No demographic published. | Hospital volume, physician volume. | In hospital mortality: Five procedures have a significant relationship: total cholecystectomies, coronary artery bypass surgeries, resection of abdominal aortic aneurysms, partial gastrectomies and colectomies. |
| Sequeiros 2010 (112)<br>(Conference abstract only) | All patients with a pulmonary exacerbation of CF referred to the CF MDT at a single UK hospital site. | N=58<br>Reported demographics: No differences in age, gender or baseline spirometry. Baseline BMI significantly higher in the new home service. | Hospital care vs home care with intensive treatment by MDT vs standard home care. | FEV1 and BMI improved significantly in hospital/standard home care group.<br>Time to next pulmonary exacerbation similar in all groups. |

**Table 2.3b Table of characteristics of included systematic reviews in the scoping review**

| **Author**<br><br>**Date** | **Study Inclusion Criteria** | **Participants** | **Intervention** | **Outcomes** |
|---|---|---|---|---|
| Aubin 2012 (113) | RCT, CCT, Controlled before and after studies.<br><br>>50% of participants in the study were adults with cancer. | 51 studies<br><br>29 RCT's and 2 CCT<br><br>N= 28-1388 | An intervention designed to improve the continuity of care for cancer patients. E.g. case management, shared care and interdisciplinary team models. | Physical/functional/psychological health, satisfaction and global quality of life: no significant difference in median effect sizes between patients assigned to the intervention vs usual care. |
| Ellis 2017 (114) | Randomised controlled trials.<br><br>65 years old or older who are admitted to hospital for acute care or inpatient rehabilitation with medical, psychological, functional or social problems. | 29 RCT's<br><br>N=13,766 | Comprehensive geriatric assessment on wards or by mobile teams which included: tailoring plans to individual, MDT meetings, providing clinical leadership, involving patients and carers in goal setting. | Living at home at 3-12 months: RR 1.06 (95% CI: 1.01-1.10; n=6799)<br><br>Mortality at 3-12 months: RR 1.11 (95% CI: 0.93-1.07; n=10023)<br><br>Admission to a nursing home at 3-12 months: RR 0.80 (95% CI: 0.72-0.89; n=6285)<br><br>Dependence: 0.97 (95% CI: 0.89-1.04; n=6551) |
| McGaughey 2007 (115) | All patients who deteriorated on general adult wards in hospital | 2 cluster RCTs | The implementation of outreach using an EWS in an acute hospital setting to identify deteriorating patients versus a general ward-based care approach with no EWS and outreach. | Composite outcome (Incidence of unexpected cardiac arrest, death and unplanned ICU admissions): adjusted OR=0.98 (95% CI: 0.83-1.16, p=0.640)<br><br>Mortality: Priestly study: OR= 0.52 (95% CI: 0.32-0.85 ); MERIT study: OR= 1.18 versus 1.06 per 100 admission, adjusted p=0.752) |

| | | | | |
|---|---|---|---|---|
| Flodgren 2015 (116) | Randomised controlled trials.<br><br>Patients receiving interactive telemedicine from a HCP versus usual care. | 93 RCTs | Telemedicine used in direct patients care. Including face to face/telephone consultations. | All-cause mortality at median of 6 months follow-up: RR (95% CI): 0.89 (0.76-1.03); n=5239.<br><br>Admission to hospital at median follow-up 8 months: RR: 0.36-1.60; n=4529<br><br>Disease specific quality of life: Median difference -4.39 (-7.94 to -0.83), p=0.02 at median 3 months. N=482. |
| Gillaizeau 2013 (117) | RCTs, non RCT's, controlled before and after studies, interrupted time series analyses.<br><br>Health care professionals with responsibility for patient care | 42 studies<br><br>40 RCTs and 2 non RCT's | Computerised advice on drug dosage versus routine care. | Proportion of people with drug plasma concentrations in the therapeutic range after 2 days: pooled RR 4.44 (95% CI: 1.94-10.13) for aminoglycoside antibiotics.<br><br>Time for studies physiological parameter maintained in target range. SMD ((5% CI) for INR (Warfarin): +0.19 (0.06-0.33) and glucose (Insulin): +1.27 (0.56-1.98)<br><br>Time to achieve therapeutic control for oral anticoagulants: SMD (95% CI): -0.56 (-1.07 to -0.04)<br><br>Proportion of people with toxic drug levels: VTE for oral anticoagulants: Rate ratio (95% CI): 0.68 (0.49-0.94)/Bleeding events 0.81 (0.60-1.08). Nephrotoxicity in aminoglycoside antibiotics: RR (95% CI): 0.67 (0.42-1.06) and CMV infection with anti-rejection drugs: 0.90 |

| | | | | |
|---|---|---|---|---|
| | | | | (0.58-1.40)<br><br>Mortality or clinical adverse event for Insulin, anaesthetic agents, anti-rejection drugs and antidepressants: no difference<br><br>Length of stay: SMD (95% CI): -0.15 (-0.33-0.02) |
| Rotter 2010 (118) | RCTs, CCT, controlled before and after studies and Interrupted time series.<br><br>Hospitalised patients (inpatient and outpatient settings) with conditions managed on a clinical pathway (CPW), irrespective of diagnosis. | 27 studies<br><br>19+ RCTs; 4 CBA; 2 CCT, 2 ITS.<br><br>N=11,398 | Clinical pathways versus usual care including clinical pathways used as part of a multi-faceted intervention. | In hospital complications: OR (95% CI): 0.58 (0.36-0.94)<br><br>LOS: 11 out of 15 studies showed significant reduction in LOS. (Data could not be pooled due to heterogeneity).<br><br>In patient mortality: OR (95% CI): 0.84 (0.61-1.11)<br><br>Hospital readmission: OR (95% CI): 0.60 (0.32-1.13) |
| Urquhart 2009 (119) | RCTS, Controlled before and after studies, ITS<br><br>Patients receiving care recorded or planned using nursing record systems. | 9 trials<br><br>8 x RCTs, 1 controlled before and after study.<br><br>N=1846 | Nursing record system in hospital, community or primary care setting. | Client held records vs patient held (3x studies): no significant difference in all clinical outcomes<br><br>Paper records vs a different structure (2x studies): Pain management study: improvement in pain scores using flow sheet ($p<0.01$); Integrated record study: higher accuracy of planned LOS when using planning forms ($p=0.02$).<br><br>Manual nursing care planning with computerised nursing care planning: (1x study): |

| | | | | |
|---|---|---|---|---|
| | | | | No significant difference in clinical outcomes |
| Lawrence 2015 (120) | Randomised Controlled Trials<br><br>People with age related cataracts. | 2 x RCTs | Cataract extraction and IOL implantation done as day cases compared to inpatient cases. | Best corrected visual acuity 6/18 or better in operated eye four months postoperatively: Mean change: 4.1, p=0.74.<br><br>Post-operative complications. Castells study: (Intra-ocular pressure >30 mmHg): RR (95% CI): 3.33 (1.21-9.16). Galins study: none<br><br>Quality of Life: Mean change of VF14 scores (25.2 in day case vs 23.5 for inpatient, p=0.30). |
| Stroke Unit Trialists 2013 (121) | Randomised controlled trials<br><br>People admitted to hospital who had suffered a stroke (excluding subarachnoid haemorrhage and subdural haematoma). | 28 RCT's<br><br>N=5855 | Organised inpatient (stroke units) care providing multi-disciplinary staffing delivering a complex package of care to stroke patients in hospital compared to an alternative service. | Mortality: OR (95% CI): 0.81 (0.69-0.94), p=0.005.<br><br>Death of institutionalised care: OR (95% CI): 0.78 (0.68-0.89), p=0.0003.<br><br>Death or dependency: OR (95% CI): 0.79 (0.68-0.90) |

**Table 2.4 Summary table of outcomes of included studies in the scoping review**

| | | ASSOCIATION | | | |
|---|---|---|---|---|---|
| **THEME** | **Disease Area** | **Survival** | **Treatment rates** | **Patient reported outcomes** | **Reduced healthcare utilisation** |
| **INCREASED STAFF/BED** | COPD | + | + | NR | + |
| | All hospital admissions | + | NR | NR | NR |
| | AAA | + | NR | NR | NR |
| | Lung Cancer | NR | + | + | NR |
| **SPECIALIST CARE** | Surgical procedures | + | NR | NR | NR |
| | Stroke units | + | NR | + | + |
| | Lung Cancer | + | + | + | + |
| **CO-ORDINATION OF CARE** | Cancer | NR | NR | NA | NA |
| | Acute care | NA | NR | NR | NA |
| | Elderly care | NA | NR | NA | + |
| | Lung Cancer | NA | + | + | NR |
| **CLINICAL PATHWAYS** | All hospital patients | NA | NR | + | + |
| **RECORD KEEPING** | All patients in hospital, primary care or community | NA | NA | + | + |
| **USE OF TECHNOLOGY** | Heart failure | NA | NR | + | NR |
| | Diabetes | NR | + | NR | NR |
| | Lung Cancer | NR | + | NR | NR |
| **HOME CARE** | Cataract surgery | NR | NA | NA | NA |

+: positive association reported; NA: No association found; NR: Not reported

2.1.5.2.1 *Staff workload*

Four studies investigated the relationship between staff workload (staff/bed) and patient outcome. (122)(108)(110)(109) Two (where one was a pilot for the other) used retrospective audit data in patients with chronic pulmonary obstructive disease (COPD), (122)(108) and two used national datasets. (110)(109) All demonstrated a significant relationship between hospital staffing workload and mortality.

In COPD the authors also demonstrated that the percentage of patients staying in hospital over seven days decreased with greater number of respiratory consultants (>2: OR 0.67, 95% CI: 0.60-0.98 compared to <1.6); presence of an early discharge scheme (OR 0.69, 95% CI 0.60-0.81) and local guidelines for follow-up of COPD (OR 0.84, 95% CI 0.72-0.98).(108) Similar findings were not reproduced with general medical staff at senior or junior level suggesting that it is not only staffing numbers that is important, but also their speciality.

A large study of national datasets reviewing 7.7 million hospital admissions in England over four years, (110) incorporated numerous independent variables in a weighted linear regression analysis to predict hospital standardised mortality ratios. They found a key predictor of mortality was the ratio of hospital doctors to beds (regression co-efficient: -0.47; 95% CI: -0.64 to -0.30; p <0.001).

Ozdemir et al reviewed mortality rates in 9877 patients admitted with a ruptured abdominal aortic aneurysm (AAA) over a five-year period from 153 trusts, categorising into high, expected and low mortality trusts. (109) Low mortality trusts had a significantly greater mean number of staff per bed (doctors: 0.922 versus 0.513, p<0.001; consultants: 0.316 versus 0.168, p<0.001; nurses: 2.341 versus 1.770, p<0.001) compared to high mortality trusts.

*2.1.5.2.2 Specialist care*

Two studies explored the impact of specialist care. (111,123) Hannan et al investigated the hypothesis that hospitals and doctors that have a high degree of specialisation, as determined by case volume for a specific procedure, are associated with better outcomes. (111) The authors studied the number of times five specified surgical procedures were performed by the same surgeon in any hospital in one year (n= 48,139 patients). They found that higher physician volume was significantly associated with lower inpatient mortality rates for the following procedures: coronary artery bypass, aneurysm resections, partial gastrectomies and colectomies.

The existence of specialised units has also been shown to improve care in stroke as demonstrated by a Cochrane review comparing inpatient stroke unit care with an alternative service. (123) The review reported a significant reduction in several outcomes: death (unadjusted OR 0.76, 95% CI 0.66-0.88, p=0.0001); death/institutional care (unadjusted OR 0.76, 95% CI 0.67-0.86), p=0.0001) and death/dependency (unadjusted OR 0.80, 95% CI 0.67-0.97), P=0.00001).

*2.1.5.2.3 Co-ordination of care*

Three Cochrane reviews (46 included studies) were identified investigating how the co-ordination of care affects outcomes for patients. (113–115) Respectively, they examined care across a cancer pathway, in an acute setting and chronic condition (frailty).

Two interventions were not beneficial, (113,115) although disparities in study designs, settings and outcomes limit the confidence in this conclusion. One review (n=51 studies) investigated how interventions designed to improve the continuity of care for cancer patients

(including case management, shared care and interdisciplinary team models) impacted patient health (physical/functional health and quality of life). (113) No significant difference was reported in the median effect sizes for the patient health outcomes between the interventions versus usual care group.

The other review (n=2 studies) that reported no conclusive improvement in outcome, evaluated the implementation of an outreach team using a 'Early warning system' (EWS) in an acute hospital setting on hospital mortality, unanticipated ICU admissions, ICU admission, length of stay and adverse events in patients on general hospital wards. (115)

The third review (29 RCTs, n=13766 patients) assessed how introducing specialist co-ordinated care known as 'Comprehensive Geriatric Assessment' (CGA) impacted on patient outcomes (mortality, likelihood of living at home and dependence). (114) CGA includes a ward/mobile team that tailors treatment plans to the individual and MDT meetings. They found that CGA increases the likelihood patients will be living at home at 3 and 12 months (RR 1.06, 95% CI: 1.01-1.1.0, 6799 participants). However, there was no significant difference in mortality.

*2.5.5.2.4 Clinical Pathways and Record Keeping*

A Cochrane review (27 studies) evaluating the impact of clinical pathways found a decrease in hospital complications (pooled OR 0.58 (95% CI 0.36-0.94)) compared to usual care but no difference in patient mortality or hospital readmission. (124) Eleven out of 15 studies that looked at length of stay as an outcome, reported a significant reduction. Urquhart et al investigated the effects of nursing record systems on patient outcomes. (119) Four (n=491) out of 5 (n=795) studies that examined patient related outcomes found no significant difference, however there were some reports of improved patient satisfaction.

*2.5.5.2.5 Use of Technology*

Two Cochrane reviews evaluated the use of technology to improve patient outcomes. (116,117) Flodgren et al investigated the impact of patients receiving care from a health care professional via telemedicine. Meta-analysis was possible in the studies involving heart failure patients (n=16, 5239 patients) and diabetic patients (n=16, 2768 patients). For heart failure patients, there was no significant difference in all-cause mortality but some evidence of improved quality of life (n=482; MD -4.39, 95% CI -7.94 to -0.83, $p<0.02$) for those allocated to telemedicine compared to usual care at a median of three months follow-up. In the studies involving diabetic patients, there was better diabetic control in the telemedicine group defined by a lower glycated haemoglobin level at a median of nine months (MD -0.31, 95% CI -0.37 to -0.24; $p<0.00001$).

The other review investigated the use of a computer programme to generate advice on drug dosage on drug or disease specific outcomes. (117) A variety of drugs were evaluated with some evidence for increased therapeutic availability of certain drugs. For example, there was increased time that a patients' INR/glucose was in the desired range (SMD +0.19, 95% CI 0.06 to 0.33 for INR; +1.27, 95% CI 0.56 to 1.98 for glucose).

*2.5.5.2.6 Home care and day case procedures*

Lawrence et al (2 studies) showed no impact of day care versus inpatient surgery for age related cataract on visual acuity, risk of post-operative complications and quality of life. (120)

Home treatment was not shown to be beneficial in a single site case control study that looked at the outcome of patients with cystic fibrosis treated for a pulmonary exacerbation in a home setting (with or without intensive MDT input) or in hospital. (112) The hospital group

demonstrated significant improvements in FEV1 and body mass index (BMI) measures than the home group with MDT input.

*2.5.5.2.7 Risk of Bias*

The risk of bias across all the included observational studies was high and is summarised in Table 2.5a. Details of attrition and reporting bias were unclear mainly due to poor reporting. Table 2.5b summarises the risk of bias for the systematic reviews. Overall, all the studies had a low risk of bias having followed Cochrane methodology.

**Table 2.5 Assessment of risk of bias tables in included studies in the scoping review**

**Table 2.5a Assessment of risk of bias in included cross sectional observational studies**

| **Study** | **Confounding** | **Selection Bias** | **Misclassification Bias** | **Performance Bias** | **Attrition Bias** | **Detection Bias** | **Reporting Bias** |
|---|---|---|---|---|---|---|---|
| Ozdemir 2015 | Moderate | Moderate | High | High | Moderate | High | Unclear |
| Price 2006 | High | High | High | High | Unclear | High | Unclear |
| Roberts 2003 | High | High | high | High | Unclear | High | High |
| Jarman 1999 | High | High | high | High | High | High | High |
| Hannan 1989 | Unclear | High | High | High | Unclear | High | Unclear |
| Sequerios 2010 | Unclear | High | High | Unclear | Unclear | High | High |

**Table 2.5b Assessment of risk of bias in included systematic reviews**

| Study | Study Eligibility criteria | Identification and Selection of studies | Data collection and study appraisal | Synthesis and findings | Risk of bias |
|---|---|---|---|---|---|
| Aubin 2012 | Low | Low | Low | Low | Low |
| Ellis 2017 | Low | Low | Low | Low | Low |
| McGaughey 2007 | Low | Low | Low | Low | Low |
| Flodgren 2015 | Low | Low | Low | Low | Low |
| Gillizeau 2013 | Low | Low | Low | Low | Low |
| Rotter 2010 | Low | Low | Low | Low | Low |
| Urquhart | Low | Low | Low | Low | Low |
| Lawrence 2015 | Low | Low | Low | Low | Low |
| Stroke Unit Trialists 2013 | Low | Low | Low | Low | Low |

2.1.5.3 Discussion

To my knowledge this is the first systematic scoping review of the delivery of healthcare across a broad range of settings. The literature highlighted the following themes: staff workload, specialist care, co-ordination of care, use of technology, home care/day case procedures and clinical pathways/record keeping. The most robust literature implies that specialist staffing and co-ordination of care may be important determinates of patient outcomes.

The primary aim of the scoping review was to uncover areas for improvement in the main review process. The following three lessons are highlighted.

*2.1.5.3.1 Data collection was an iterative process*

Several searches and changes to searches with the involvement of experts in literature searching were required. The thesauri of various databases were studied to identify appropriate subject terms likely to identify relevant articles. Small changes in wording of terms raised vastly differing search outputs. The WHO paper on issues related to health systems research illustrate this in a search for the term "health systems research". (93) 192 citations are revealed in MEDLINE, of which approximately half are based in Canada. However, the term "health services research" appears 37,894 times, of which half of the corresponding authors are in the United States or UK. (93) Similarly, the search of the term "Delivery of Health Care" in MEDLINE discovered 82,524 results. Whereas searching "Organisation of Health Care" showed 78 results.

Two further techniques were required to ensure a comprehensive search strategy: free text searching and snowballing. The initial search results were scanned by the team for relevance. On further discussion, relevant articles not captured were highlighted. Therefore, the key words from these articles were examined and incorporated as free text into the search strategy. In addition, the references of papers were scanned for further sources.

*2.1.5.3.2 The search refined the inclusion/exclusion criteria*

A total of 765377 studies were found using an initial search strategy but after several modifications to the strategy the number of studies was reduced to a manageable number. The majority of articles were excluded due to inappropriate intervention or outcomes. This process clarified the boundaries required for the main review. For example, many studies examined the impact of adherence to treatment guidelines on patient outcomes. Discussion amongst the

research team concluded that this revealed little about optimal models of service delivery given that such guidelines are well established and accepted as 'gold standard' care. Additionally, several epidemiological studies used data from the early 1990's. The management of lung cancer has changed considerably since this time and its findings are likely to be irrelevant to modern practice. Consequently, a date restriction from 1st January 2000 onwards was applied. Lastly, publications from a variety of countries resulted from the search. A key purpose of the main review is to apply the findings to the delivery of lung cancer services in the UK. Therefore, the results were restricted to countries where the management of lung cancer is comparable to the UK such as Australia, Canada, United States and Western Europe.

*2.1.5.3.3 The scoping review demonstrated heterogeneity in study intervention, results and design.*

Firstly, the importance of a clear definition of the intervention was highlighted by the included Cochrane review examining the impact of a comprehensive geriatric assessment (CGA) in older adults admitted to hospital. (114) The authors report variation in the interpretation of the definition of CGA. One trial defined CGA as a specialist medical and mental health unit. Whereas, in another study CGA was described as an elderly care physician reviewing cases at the point of discharge. This limited interpretation of results.

Therefore, a model of the intervention for the main review was formulated by the research team to guide the search strategy and clarify the inclusion criteria. After a search of the literature for an established framework, an adaptation of the model of care described by the previously mentioned Australian publication was developed. (98) The final definition of a lung cancer service delivery model was: "A multifaceted concept which defines the way lung

cancer care is delivered including the roles, structure for the delivery of health services and co-ordination of care".

Secondly, the boundaries of included interventions were explored. For example, an important component of health systems research is cost effectiveness. However, due to resource limitations this was considered to be out of the remit of this review. Similarly, to increase applicability to a hospital setting and limit the variability in studied interventions, interventions that occurred before the point of referral were not included (for example screening trials and community lung cancer awareness programmes).

Heterogeneity in results highlights that a structured approach to analysis is required to enable meaningful interpretation of the data. Established methods of evidence synthesis centre on synthesising randomised controlled trials. However, the majority of data collected in the scoping review was observational in nature in keeping with most health systems research. (125) Qualitative and quantitative data were included in the results, therefore an approach to joint synthesis that considers differing interventions is required. A summary of the main methods of joint synthesis are considered in Table 2.6.

**Table 2.6 Summary of approaches to joint synthesis of qualitative and quantitative evidence** (125)

| **Method** | **Description** | **Strengths** | **Limitations** |
|---|---|---|---|
| Narrative summary | Narrative description with commentary and interpretation | Good for large evidence base with diverse evidence types<br>Allows flexibility | Dependent on reviewer judgement<br>No published standard |
| Thematic analysis | Identification of major recurrent themes: a summary of findings under thematic headings | Flexible approach<br>Good for diverse evidence type | Mainly descriptive based on the themes and may overlook contradictions between themes |

| | | | |
|---|---|---|---|
| Content analysis | Evidence from each study coded under thematic headings and occurrences of each theme counted and tabulated | Incorporated diverse evidence types | May overlook the context of the data<br>Over-emphasis on frequency |

The included studies could easily be categorised by subject therefore, a thematic analysis was conducted. This allowed identification of themes likely to also be important in the main review and incorporated as terms into the search strategy. However, it is recognised that despite several search iterations and expert input, the number of resulting number of articles is unlikely to represent a comprehensive review of the literature with several relevant articles in a specific disease area not being captured. That being said, the conclusions are in keeping with previous similar reviews, adding validity to the results. (126)

Finally, heterogeneity in study design meant a single risk of bias tool was not appropriate. Several tools were evaluated as part of the scoping review and will be discussed in section 2.2.5.1. The ROBIN I tool was found to be the most appropriate for the included primary studies. The assessment process of the studies in the scoping review led to the development of a modified ROBIS I tool. Specific judgement criteria were also created aimed at improving transparency and reducing judgement variability between reviewers. The modified tool and judgement criteria are shown in the appendix (A2).

### 2.1.5.4 Conclusions

A broad review of the medical literature highlights key organisational factors that impact on patient outcomes. Application of these themes and lessons learnt from the conduct of the

scoping review is likely to improve the quality and capture of the main review which will now follow

### 2.1.6 The impact of organisation of care on lung cancer patient outcomes: A systematic review

#### 2.1.6.1 Aims and Objectives

The aim of this review is to explore the association between lung cancer service delivery interventions with patient outcome in order to identify the effectiveness, benefits and challenges of such interventions. This is to provide evidence about best practice approaches for commissioners and health policy makers. The specific objectives are:

1.) What initiatives/models have been established which aim to improve the delivery of care for patients (in the UK and other comparable countries) referred for the investigation of symptoms of lung cancer?
2.) What are the characteristics of lung cancer service delivery interventions that have improved patient outcomes?

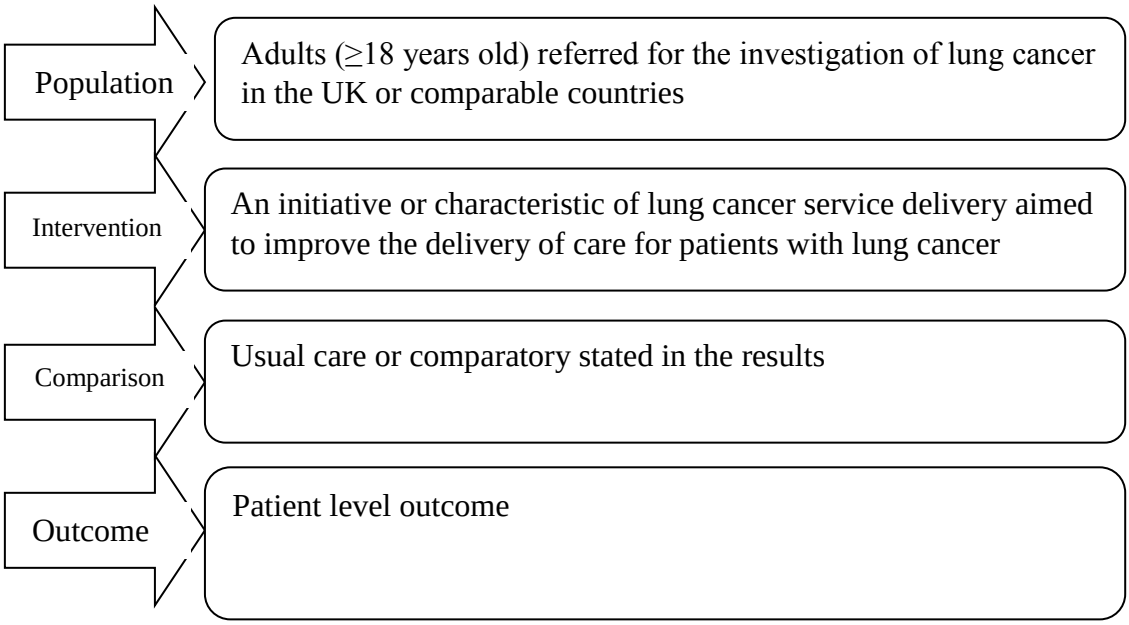
## 2.2 Methods

Standard systematic review methodology was used with reference to the Cochrane Handbook for Systematic Reviews of Interventions. (105)

### 2.2.1 Criteria for considering studies for this review

The selection criteria are summarised in Figure 2.3.

**Figure 2.3 PICO chart detailing inclusion criteria for the systematic review**




#### 2.2.1.1 Types of studies

This review considered randomised controlled trials, all types of observational studies (that included over one participant), systematic reviews (where at least one database was searched) and qualitative studies. Narrative reviews, commentaries, non-human/laboratory studies and

single case reports were not considered. Conference abstracts or reviews were only included if a full report was found. Studies published in the English language were considered.

2.2.1.2 Types of participants

Studies were included if the participants were over the age of 18 and referred for the investigation of lung cancer.

2.2.1.3 Types of Interventions

Any type of intervention that aimed at investigating a specific aspect or structural characteristic of the delivery of care for lung cancer after the point of referral to a specialist for management or diagnosis was considered. This included studies that studied a specified intervention as well as studies that described the impact of different existing organisation of care models on patient outcomes.

A definition of a model of lung cancer service delivery was developed from the scoping review as defined in section 2.1.5.3.3

Key elements of service-based interventions were informed by the scoping review and provide guidance to the types of interventions included. This encompassed (but were not restricted to): the care delivery process, case management, staffing profile, communication structures, MDT working, interdisciplinary care, care co-ordination, proximity to care and timeliness of care.

For relevance, studies were considered if the intervention was conducted in the UK or comparable countries including New Zealand, Australia, Canada, USA or western Europe.

A key aim was to collate evidence on how service interventions directly impact patients. Results from the scoping review highlighted boundaries which are listed below. Studies where the focus (or could not be separated) from the following were excluded.

1.) Education aimed to alter patient/staff behaviour
2.) Informing clinical practice guidelines or treatment regimens
3.) Assessing the uptake or impact of existing guidelines
4.) Continuing professional education

The comparator group could be usual care, or another intervention in equivalent settings.

2.2.1.4 Outcomes

The following outcomes were identified as important in the scoping review: survival, patient experience, timeliness of care and treatment rates. Therefore, these patient related outcomes were the primary focus of the review. Studies investigating cost effectiveness were out of the scope of the review.

## 2.2.2 Search methods for identification of studies

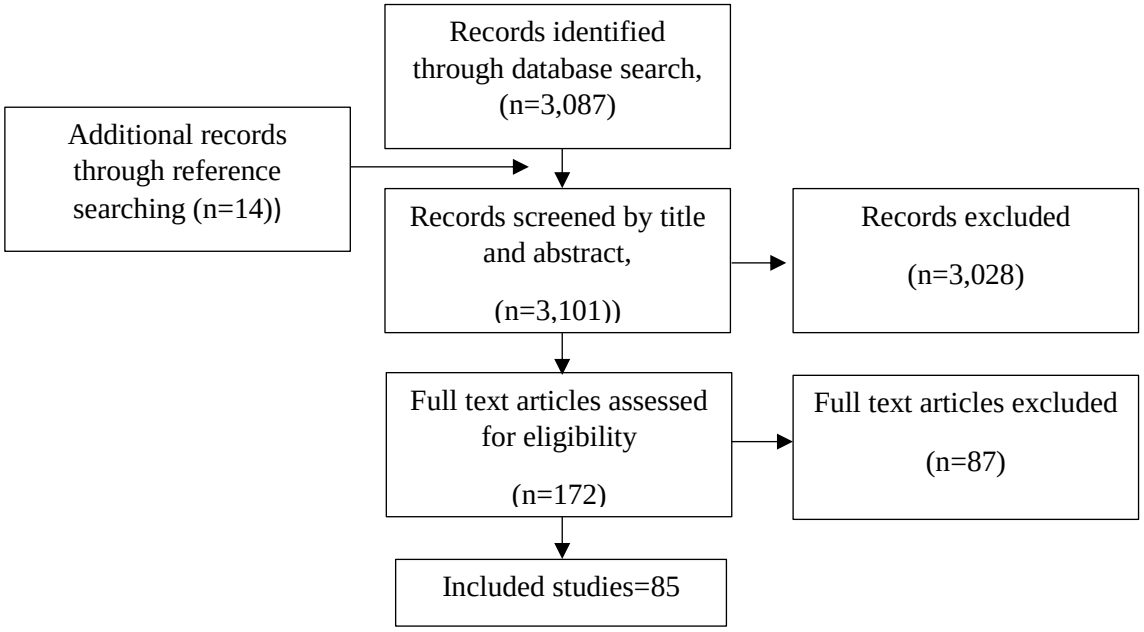
The following databases were searched for articles: MEDLINE (via Ovoid), EMBASE (Wiley) CENTRAL, Cochrane Library (Wiley) CENTRAL and PubMed. A full search strategy is included in the appendix (A3). Electronic reference databases were searched using a combination of Medical Subject Health (MeSH) terms, free text and key words. Articles were included if published between 1 January 2000 - November 2018, in English and available in full text.

Hand searching, citation checking and snowballing search strategies were also used. Extensive searches of national and international websites, review of reference lists of relevant publications and contact with field expert were conducted.

### 2.2.3 Study selection

Titles and abstracts of studies were retrieved using the search strategy and screened independently by four review authors (J.A, A.T, SK and C.G) to identify studies that meet the inclusion criteria outlined in Figure 2.4. The full text of potentially eligible studies was retrieved and assessed for eligibility by two reviewers Disagreement regarding study inclusion was resolved by discussion between the research team.

**Figure 2.4 PRISMA flow diagram for the systematic review**




## 2.2.4 Data extraction

The primary reviewer (J.A) used a standardised form developed from the results of the scoping review to extract data from the primary studies. Extracted information included assessment of study quality, setting and population. In addition, details of the intervention, study methodology and outcomes were documented. Three reviewers (A.T, CG, A.B) checked and validated the extracted information. Any discrepancies identified were resolved through discussion.

## 2.2.5 Assessment of Risk of bias

### 2.2.5.1 Selection of risk of bias tools

A wide range of study designs were included as found in the scoping review. Pubmed and Google Scholar were used to search for relevant tools. The ROBIN-I tool was used in the

scoping review to assess applicability for non-randomised studies and the Cochrane Risk of Bias tool was used to assess randomised controlled trials.

The majority of studies assessing the impact of the organisation of care are non-randomised studies based on real world evidence. (107) This is for three reasons. Firstly, service delivery interventions are complex and consist of several components that can be applied and assessed in several ways. Secondly, interventions need to be in place over a long period of time during which the usual management of the studied condition is carried out, before an accurate assessment can be made. Finally, linked databases and electronic health records represent large population cohorts in the investigation of organisational interventions. Therefore, a randomised design, in this context, may not be feasible or reflect clinical practice. Moreover, it may be unethical, expensive and time consuming.

An evaluation of the risk of bias in non-randomised studies needs to acknowledge inherent flaws with this design and can adequately deal with confounding in different contexts, populations, comparators and follow-up times. The ROBINS-I tool is the most comprehensive tool for non-randomised studies evaluating the effects of healthcare interventions. (107) Other tools (such as the Newcastle-Ottawa tool/SIGN tool/Downs Black tool) that have been designed for observational studies, focus on the methodological quality (such as the accuracy of the results or applicability) of the study rather than the internal validity. (107,127) These tools are often used to assign an overall score to the study. This can be misleading in observational studies, because a critical weakness in a certain type of bias can be left unidentified through reporting of a composite score. Therefore, more recently published tools advocate a structured approach to the assessment of risk of bias where each type of bias is considered independently. The ROBINS-I tool is the only tool that uses this approach in non-randomised studies. Additionally, it specifically addresses the risk of bias occurring when

there is no control for factors that may affect the outcome other than the intervention. Therefore, the ROBINS- I tool was chosen to assess the observational studies included in the scoping review and subsequently modified to meet the needs of this review.

The Cochrane Risk of Bias tool was chosen for included randomised controlled trials for two reasons. (105) Firstly, this tool has been used successfully in the literature examining healthcare interventions in RCT's because it allows judgements to be used as to whether a confounding factor is likely to have affected the results. In this review a variety of interventions are considered. Therefore, flexibility to apply consideration to how a risk of bias domain applied to that outcome is important. Secondly, guidance is available from the Cochrane Effective Practice and Organisation of Care Group on how to use this tool and make judgements consistently.

2.2.5.2 Risk of bias assessment

The above tools were applied to all included studies by the primary reviewer (J.A). This was independently assessed by four second reviewers (A.T, C.G, SK and A.B) with any discrepancies resolved through discussion.

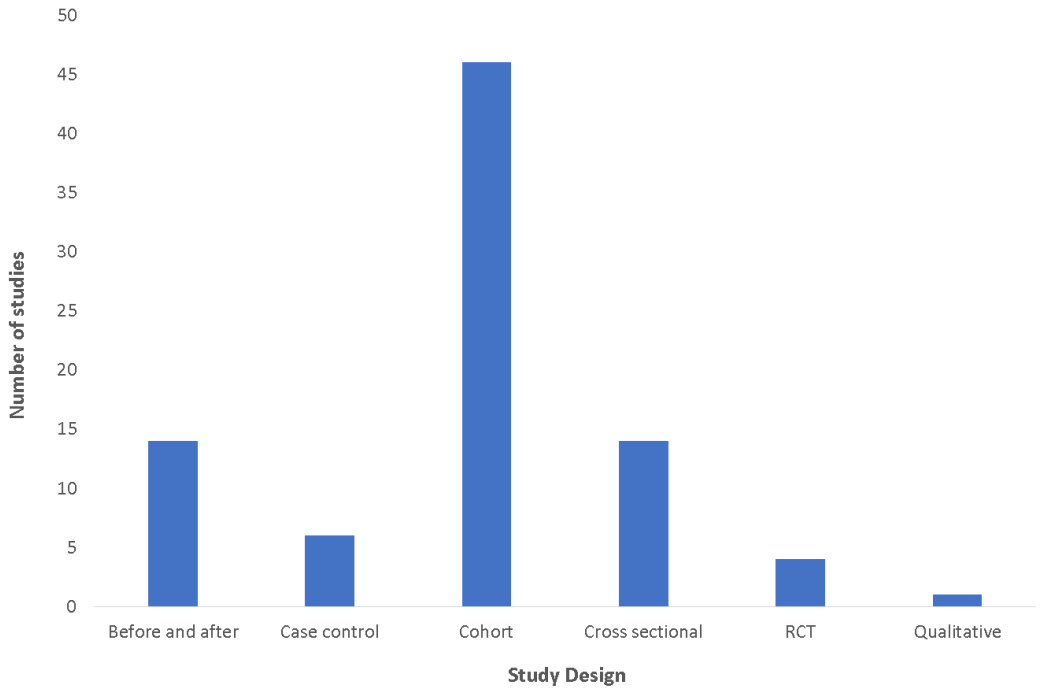
## 2.3 Results

A total of 3,087 references were identified from searching the electronic databases. After an initial screen by title/abstract and removal of duplicates, 158 studies met the inclusion criteria. Full text copies of 157 studies (full text was not able to be obtained for one study) as well as 14 studies identified through reference searching were reviewed. 87 studies were excluded at this stage because the selection criteria were not met. This was mainly because the intervention or population was inappropriate. Therefore, a total of 84 articles were included in the final analysis.

### 2.3.1 Study Design

Figure 2.5 graphically demonstrates the distribution of studies by study design. All but 4 (95%) studies were observational with over half (54%) being cohort design.

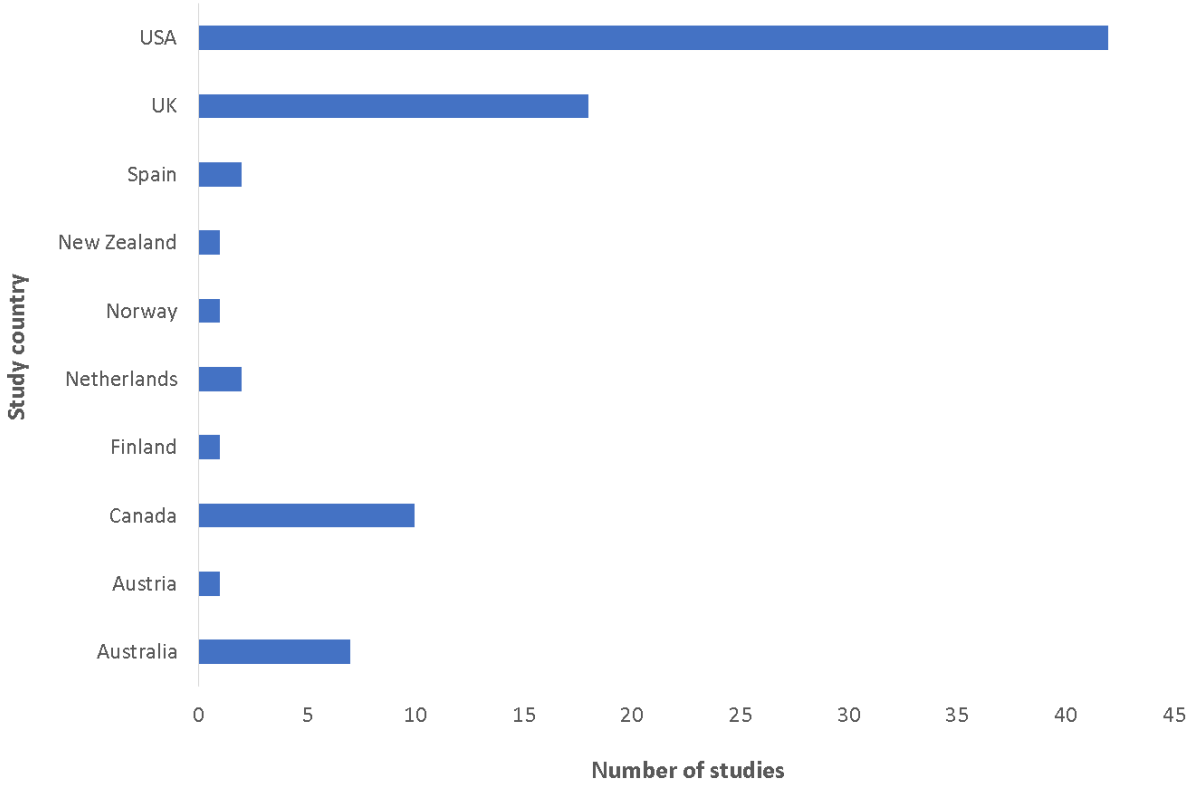
**Figure 2.5 Number of studies by study design**



## 2.3.2 Geographical distribution

The geographical distribution of the included studies is shown in Figure 2.6. Approximately half (49%) of the studies are from the USA. The second most frequent country (21%) is the UK.

**Figure 2.6 Number of studies by country**




## 2.3.3 Study time frames

The majority of studies were retrospective in nature using data ranging from 1985 to 2017. Approximately one third of studies (34%) included data from the nineties. The management of lung cancer in the UK has changed since this era and this should be taken into account when interpreting the results.

### 2.3.4 Results by study theme

The literature describes a range of interventions employed to improve access and delivery of care to patients referred for the investigation of a diagnosis of lung cancer. Two major themes were identified: Specialist care and the co-ordination of care. The subthemes associated with each theme are detailed in Table 2.7. The following section reports the results of each theme.

**Table 2.7 Components of study themes**

| THEME/SUBTHEME | Number of studies | Number of patients | Intervention | Comparator |
|---|---|---|---|---|
| ***SPECIALIST CARE*** | | | | |
| **Hospital volume** | 23 | 954,709 | High volume hospitals | Low volume hospitals |
| **Surgeon procedure volume** | 3 | 58,387 | High volume surgeons | Low volume surgeons |
| **Surgeon speciality** | 4 | 119,495 | Thoracic surgeons | General/cardiac surgeons |
| **Hospital teaching status** | 4 | 84,340 | Teaching hospital | Non-teaching hospitals |
| **Specialist centre** | 10 | 607,215 | Specialist centre | Non-specialist centre |
| **Site of care** | 8 | 99,651 | Low travel burden | High travel burden |
| **Specialist staff** | 6 | 192,336 | Seen by specialist staff | Not seen by specialist staff |
| **Staff workload** | 3 | 109,711 | Low staff workload | High staff workload |
| ***CO-ORDINATION OF CARE*** | | | | |
| **MDT meetings** | 9 | >19,232 | Discussed at an MDT meeting | Not discussed at an MDT meeting |
| **MDT clinic** | 4 | >1345 | Managed in an MDT clinic | Not managed in an MDT clinic |
| **Rapid diagnostic programme (RDP)** | 7 | 779 | Managed on an RDP | Not managed in an RDP |
| **Care Co-ordination programme (CCP)** | 7 | >11269 | Managed on a CCP | Not managed on a CCP |
| ***OTHERS*** | | | | |
| **Patient led care** | 2 | 3125 | Patient led care | Usual care |
| **Nurse led follow-up** | 1 | 203 | Nurse led follow-up | Usual care |
| **Technology based interventions** | 3 | 566 | Use of technology | Usual care/different technology |

#### 2.3.4.1 The impact of specialist care

The impact of specialist care was the focus of 61 studies in total. These studies were categorised into eight subthemes: The impact of 1.) Annual hospital volume 2.) Annual surgeon procedure volume 3.) Surgeon speciality 4.) Hospital teaching status 5.) Specialist centres 6.) Site of care 7.) Specialist staff and 8.) Staff workload. Each subtheme will be discussed in turn with results presented in table format.

##### *2.3.4.1.1 Hospital volume – outcome relationship*

23 studies (n= 954,709 patients) examined the hypothesis that hospitals that have a high degree of specialisation determined by case volume are associated with better patient outcomes. 21 studies investigate the hospital volume-outcome relationship after lung cancer resection reporting differing survival outcomes. (128–147) Table 2.8 summarises the outcomes for these studies of which 15 (65%) were conducted in USA.

All studies were observational in nature with only one study based on clinical data. (132) The remaining were based on administrative data. The number of patients and hospitals varied widely. In all studies the results were adjusted for case mix, but the variables used differed. Similarly, there was variability in cut off values describing hospital volume categories. Cut off values tended to be based on splitting volume into equal groups and further rationale was unclear in the papers.

**Table 2.8 Outcomes for studies investigating the hospital volume-outcome relationship in patients undergoing surgical resection for lung cancer**

| Author/country | Data source | Data year | No patients | No hospitals | Volume categories (cases/year) | Outcome<br>High volume Centre (HVC) compared to low volume centre (LVC) |
|---|---|---|---|---|---|---|
| Bach et al<br>USA (128) | SEER database<br>(only >65 years) | 1985-1996 | 2116 | 76 | 1-8;9-14;15-19;20-66;67-100 | 30-day mortality: 3% vs 6%<br>5-year mortality: 56% vs 67%<br>Adjusted 30-day mortality OR: 0.48, p<0.001<br>Adjusted HR for overall survival: 0.77, p=0.003 (LVC reference) |
| Birkmeyer et al<br>USA (140) | Medicare and NIS database | 1994-1999 | 85,973 | 2753 | Unclear | 30-day mortality: 4.2% vs 6.4%<br>Adjusted operative mortality OR for lobectomy: 0.70 (95% CI 0.60-0.81) (LVC reference)<br>Adjusted operative mortality OR for pneumonectomy: 0.62 (95% CI 0.50-0.77) * |
| Cheung et al<br>USA (141) | Florida Administrative Database | 1998-2002 | 13,469 | 13469 | Unclear | 30-day mortality: 1.6% vs 2.7%, p<0.001<br>90-day mortality: 4% vs 7.5%, p<0.001<br>5-year mortality: 59.3% vs 63.5%, p=0.002<br>Adjusted HR: 0.93 (95% CI 0.879-0.992), p=0.027 (LVC reference) |
| Hannan et al<br>USA (142) | New York State administrative database | 1994-1997 | 32,000 | 178 | Unclear | Absolute difference in mortality: 1.7%<br>Observed mortality rate: 1.86% vs 3.05%<br>Risk adjusted inpatient mortality in LVC 1.65% higher than in HVC (p=0.006) |
| Luchtenborg et al<br>UK (148) | Hospital Discharge Data and National Cancer Data | 2004-2008 | 134,293 | 83 | <70; 70-99;100-129;130-149; ≥150 | Overall mortality HR: 0.78 (95% CI 0.67-0.90), p<0.01 (LVC reference)<br>30-day mortality: 0.58 (95% CI 0.38-0.89), p=0.07<br>1-year mortality 0.80 (95% CI 0.67-0.95), p=0.01<br>>1-year mortality 0.84 (95%CI 0.71-0.99), p=0.10 |
| Stukenborg et al<br>USA (143) | California State Hospital Discharge data | 1996-1999 | 14,456 | 330 | Unclear | In hospital mortality OR: 0.76 (95% CI 0.64-0.90), (LVC reference)<br>No significant association if volume expressed as a continuous variable |

| | | | | | | |
|---|---|---|---|---|---|---|
| Lieberman-Cribbin et al USA (144) | New York State administrative database | 1997-2011 | 28,471 | NR | <=7.75;7.76-16.59;16.60-39.59;>39.59 | Mean patient risk estimate for mortality: (+/-SD): 0.027 (+/- 0.028) vs 0.035 (+/- 0.034) |
| Moller et al UK (139) | Hospital discharge data and national cancer registration data | 2006-2010 | 15,738 (NSCLC) | 152 (primary care trusts) | 1-75;77-112;114-155;156-186;189-287 | 30-day mortality: 0.5% vs 1.0%, p=0.01<br>90-day mortality: 2.2% vs 3.1%, p=0.02 |
| Tchouta et al USA (146) | Administrative database (HCUP/NIS) (Robotic VAT lobectomy) | 2008-2013 | 8,253 | NR | 1-3;4-6;7-14;>=15 | Adjusted OR for mortality: 0.134, p<0.001, (LVC reference) |
| David et al USA (138) | California Cancer Registry | 2004-2011 | 7587 (Stage I NSCLC) | >50 | <20;20-50;>50 | Adjusted overall HR for survival (HVC reference): 1.777 (95% CI 1.474-2.141)<br>Better cancer specific survival for HVC (log rank test, p<0.0001) |
| Park et al USA (149) | HCUP/NIS (VATS procedures) | 2008 | 6,292 | NR | <20;>20 | No significant difference in in hospital mortality |
| Urbach et al Canada (147) | National database for Ontario | 1994-1999 | 5156 | 54 | (Average) 18.2;45;86;129.4 | No significant difference in risk of death or adjusted relative risk of death |
| Pezzi et al USA (130) | National Cancer Database | 2007-2011 | 124,418 | 1233 | <=32;33-85;86-130;>=131 | 30-day mortality: 1.7% vs 3.7%, p<0.05<br>90-day conditional mortality: 2.2% vs 2.9%, p<0.05<br>Adjusted OR for 30-day mortality: 2.1 (95% CI 1.7-2.6), reference HVC<br>Adjusted OR for 90-day mortality: 1.3 (95% CI 1.2-1.5), reference HVC |
| Finlayson et al USA (131) | NIS | 1995-1997 | 21,890 | 674 | (Average) <19;19-27;>37 | Adjusted OR for inpatient mortality for lobectomy: no significant difference<br>Adjusted OR for inpatient mortality for pneumonectomy: no significant difference |
| Freixinet et al Spain (132) | Multicentre prospective data | 1993-1997 | 2994 | 19 | 1-43;44-54;>=55 | No significant difference in overall adjusted 30 day or 5-year mortality |
| Simunovic et al Canada (133) | Ontario Cancer Registry | 1990-2000 | 2698 | 67 | <=32;33-85;86-130;>=131 | Inpatient operative death: 5.8% vs 2.4%<br>In hospital adjusted operative mortality OR: No significant difference |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | Long term patient survival HR for LVC (reference HVC): 1.3 (95% CI 1.1-1.6), p<0.01 |
| Sioris et al Finland (134) | National cancer registries | 1998-2002 | 4878 | 26 | 0-4;5-10;11-20;>20 | Adjusted OR for inpatient mortality: no significant difference<br>Adjusted OR for cancer survival for HVC: 0.8 95% CI (0.7-0.9), p=0.01 (reference LVC)<br>Adjusted OR for overall survival for HVC: 0.8 (95% CI 0.8-0.9), p=0.01(reference LVC) |
| Hollenbeck et al USA (135) | HCUP-NIS | 1993-2003 | 90,088 | NR | Unclear | Operative mortality: 2.7% vs 4.9%<br>Adjusted operative mortality OR: 1.4 (95% CI 1.2-1.7), p<0.05 |
| Li et al Netherlands (136) | Amsterdam Cancer Registry | 1998-2003 | 1591 | 20 | <40;40-59>=60 | 5-year mortality HVC vs LVC: 50% vs 53%<br>HR for mortality for HVC: 1.18 95% CI (0.88-1.60) |
| Birkmeyer et al USA (129) | SEER, Medicare/NIS | 1992-2002 | 4325 | 407 | <9;9-17;18-27;28-46;>46 | 5-year survival HVC vs LVC: 37.5% vs 43.5%<br>Adjusted HR for death for HVC: 0.83 (95% CI 0.78-0.89) reference LVC<br>Adjusted HR for death for those surviving the perioperative period for HVC: 0.83 (95% CI 0.77-0.90), reference LVC |
| Bilimoria et al USA (137) | NCDB | 1994-1999 | 40,754 | 1528 | <21;>83 | 60-day mortality HVC vs LVC: 5.5% vs 6.4%, p<0.05<br>5-year overall survival HVC vs LVC: 36%, 32.7%, p<0.05<br>5-year conditional survival HVC vs LVC: 38.1% vs 35%, p<0.05<br>Adjusted perioperative HR for death for LVC: 1.31 (95% CI 1.14-1.51), p<0.0001 (reference HVC)<br>Adjusted 5-year HR for death for LVC: 1.09 (95% CI 1.04-1.14), p<0.0001 (reference HVC)<br>Adjusted conditional 5-year HR for death for LVC: 1.06 (1.01-1.12), p=0.018 (reference HVC) |

SEER=Surveillance Epidemiology and Ends Results Cancer Registries; NIS: National Inpatient Sample Database; HCUP: Healthcare cost and utilisation project; NSCLC: Non-small cell lung cancer; VATS: Video assisted thoracoscopic surgery; OR: Odd ratio; HR: Hazard ratio; * Statistically significant result favouring HVC

Twelve studies conclude that patients in hospitals with higher procedure volumes have significantly lower mortality. (128–130,134,137–142,146,148) These studies estimate a decrease in 30-day mortality rates of between 0.5%-3% between the highest and lowest volume centres.

Bach et al used Surveillance Epidemiology, and End Results (SEER) Program data linked to Medicare hospitalisations and the Nationwide Inpatient Sample data and examined 2118 patients over the age of 65 with NSCLC from 1985-1996. (128) The authors divided volume into five groups and used survival models to examine the association between hospital volume and survival. They found a 30-day mortality of 3% vs 6% favouring high volume centres (HVC). This paper was the first to report longer term survival with improved 5-year mortality of 56% in high volume centres (HVC) compared to 67% in low volume centres (LVC).

The following year (2002) Birkmeyer et al and Hannan et al published findings on the volume-outcome relationship. (140,142) Birkmeyer used Medicare claims and National Inpatient Sample (NIS) data to examine 8 different major cancer resections from 1994 to 1999 including 75,563 patients undergoing lobectomy of the lung and 10,410 pneumonectomies. They divided volume into quintiles and found that the odds of death in those undergoing a lobectomy at a high volume hospital were 30% less likely (OR: 0.70, 95% CI: 0.60-0.81) as an inpatient compared to those being operated on in a low volume centre when adjusted for age >75 years, female sex, black race, non-elective admission and Charlson co-morbidity score of ≥3 and 38% less likely for pneumonectomy (OR: 0.62 (95% CI 0.50-0.77)). In 2007 the authors published a further paper using the same data bases and found that HVC had better 5 year survival (adjusted HR for mortality for HVC: 0.83 (95% CI: 0.78-0.89).(129) For the subgroup of patients surviving the perioperative period, HVC's remained significantly

associated with better survival (adjusted HR for mortality for HVC: 0.83 (95% CI 0.77-0.90)). Bilmoria et al replicated these findings in 2008 (adjusted conditional 5-year HR for LVC: 1.06 (95% CI 1.01-1.12), p=0.018). (137) It is notable that the longer-term survival outcomes reported by Birkmeyer and Bilmoria are modest in comparison to the perioperative outcomes.

Cheung et al added further long term outcome data to the literature with their findings examining 13,469 patients undergoing lung resection in the state of Florida using an administrative database. (141) A decrease in 30-day mortality of 1.1% for high volume centres was reported and this effect was sustained at 90 days (mortality rate for HVC ($1^{st}$ tertile) vs LVC ($3^{rd}$ tertile): 7.5% vs 4%, p<0.001) and 5 years (63.5% vs 59.3%, p=0.002).

More recent publications (2013 onwards) quote modest reductions in 30- and 90-day mortality rates compared to the earlier studies. (130,139) UK based study by Moller et al quote a 30-day mortality rate decrease of 0.5% and 90 day of 0.9%. (139)

Several of the studies present findings as adjusted odd ratios of early post-operative death. (128,130,131,140,143,146) Quoted figures vary from 0.13 by Tchouta et al to 0.70 by Birkmeyer et al favouring HVC's. (140,146) However, comparison of odds ratios in studies that have different methods of categorising hospital volume should be undertaken with caution. In addition, it should be noted that Tchouta et al investigated 8,253 patients undergoing robotic video assisted thoracoscopic (VAT) operations rather than all resections for lung cancer. (146)

Stukenborg et al demonstrates the issue of arbitrarily defined hospital volume categories in their examination of 40,460 lung resections performed at 436 hospitals in 2007 using NIS data and three different methods. (143) They found a statistically significant relationship for hospital volume when they were categorised into quintiles (In hospital mortality OR: 0.76

(95% CI 0.64-0.90), LVC as reference), but this did not hold true when expressed as a continuous variable or expressed using restricted cubic spline regression. The authors concluded firstly, that hospital lung cancer volume is likely not to be associated with mortality; secondly, that the most important predictors of mortality are patient characteristics such as age and co-morbidities and the contribution of hospital volume to the association is relatively small and finally, that the magnitude of the impact of hospital volume is dependent on how volume is defined and entered into the logistic regression model. Their comparison of three techniques advocates the analysis of hospital volume as a nonlinear function using restricted cubic spline regression.

Seven studies did not find that high volume hospitals were associated with better outcomes. (131–133,136,143,147,149) Finalyson et al compared inpatient mortality for eight cancer resections including pulmonary lobectomy and pneumonectomy. They found a significant reduction in the unadjusted mortality risk for lobectomy in HVC of 1.2% compared to LVC (categorised as tertiles) but not for pneumonectomy. This association did not remain statistically significant after risk adjustment. The authors highlight that their results are based on patient level information from the NIS database only where long-term outcomes are not reported. This is also noted to be the case for two further studies that did not demonstrate a significant association. (135,149)

Two studies reporting non-significant results did report long term outcomes. (132,136) Firstly, Freixinet and colleagues report 30 day and 5-year mortality in a Spanish multicentre prospective study of 2994 cases. They found no difference in adjusted overall operative mortality between the hospital volume tertiles at either time point. (132) Secondly, similar results were published by Li et al for 5 year mortality rates ((50% (HVC) vs 53% (LVC)) and hazard ratio for mortality for HVC (1.18, 95% CI: 0.88-1.60).(136) This study was unique on

two accounts. Firstly, it was the only study that did not categorise volume by number of operations but by the number of newly diagnosed NSCLC cases at each centre. Secondly, the authors investigate the impact of hospital volume on receipt of treatment, finding that the odds of receiving a surgical resection at an HVC were increased by 58% compared to those at a LVC (adjusted OR: 1.58 (95% CI: 1.07-2.35), $p<0.05$).

One study found surgery in HVC did not have a significant influence on the odds of inpatient operative death for lung cancer resections but the risk of long term death was increased for LVC (HR 1.3 (95% CI 1.1-1.6), $p<0.01$). (133) However, statistical significance was not maintained when the analyses were restricted to patients where pathology data was available.

Paradoxical results were reported by a Finnish study using national registries from 1998-2002 categorising volume into quartiles. (134) Sioris et al found that very low volume hospitals (0-4 operations per year) had better cancer specific and overall survival compared to high volume hospitals (adjusted odds ratio for HVC for:- cancer survival 0.8 95% CI:0.7-0.9),p=0.01; overall survival 0.8 (95% CI 0.8-0.9),p=0.01) but there was no significant difference in adjusted analyses for inpatient mortality. The authors state that many resections in this very low volume category occurred in private hospitals suggesting that other factors are likely to influence the relationship. Finland has a health system that is publicly funded with a small private sector similar to the UK.

Six studies examine outcomes other than mortality including complication rate, readmission risk and length of stay. (128,135,139,144,146,149) These outcomes are summarised in Table 2.9. Bach et al reports lower complications rates at HVC compared to LVC which supports their hypothesis that the postoperative course at LVC is more complex. (128) This hypothesis is given further weight by a lower readmission risk at 30 and 90 days reported by Moller et al

(30-day readmission risk 19% vs 22%, p for trend=0.08;90 day readmission risk 44% vs 47%,p<0.0001) and shorter length of stay (9.35 days compared to 9.82 days at LVC) by Tchouta et al (adjusted OR for length of stay: 0.2 (SE: 0.05), p<0.001) and Park et al (shorter length of stay in HVC by 0.9 days ((+/- 0.4), p=0.001) at HVC compared to LVC. (139,146,149) However, two studies found no significant difference for complication rate (144,146) and one study for length of stay between the two groups. (135)

Two studies investigated the hospital volume- outcome relationship amongst a non-surgical population. (150,151) Goyal et al conducted a retrospective study of 338, 445 stage IV NSCLC patients diagnosed between 2004-2014 using the US National Cancer Database. (150) The authors categorised hospital volume into quartiles based on the total number of patients with stage IV NSCLC treated at an institution. They found an unadjusted survival of 6 months in the quartile 1 (LVC) compared to 8 in quartile 4 (HVC), p<0.001. In an adjusted analysis, patients treated at lower volume facilities had a significantly higher risk of death (HR for LVC: 1.1 (95% CI 1.10-1.12), reference HVC). The paper concludes that there may be a small advantage to being treated at an HVC for patients with Stage IV NSCLC.

The second study is a UK based study primarily investigating LCNS working practices. The authors presented results on the association between annual service volume and receipt of cancer specific treatment (surgery, chemotherapy and radiotherapy). (151) They found that compared to caseloads of <175 new lung cancer patients seen per year that volumes of 175-264 or ≥265 patients/year was not significantly associated with improved receipt of treatment.

**Table 2.9 Table of studies examining the relationship between hospital volume-healthcare utilisation for lung cancer resections**

| Study | Healthcare utilisation outcome |
|---|---|
| Bach et al (128) | Complication rate for HVC vs LVC: 20% vs 44%, p<0.05 |
| Liebermann-Cribbin et al (144) | Risk estimate for the highest volume quartile vs lowest volume quartile (SD):<br>- For complications: 0.247 (0.082) vs 0.241 (0.084)<br>- For long length of stay: 0.454 (0.151) vs 0.506 (0.139) |
| Moller et al (139) | For HVC compared to LVC:<br>- 30-day readmission risk: 19% vs 22%, p for trend=0.08 (HVC compared to LVC)<br>- 90-day readmission risk 44% vs 47%, p<0.0001<br>- Average length of stay: 9.35 days vs 9.82 days. Linear regression of log transformed difference for length of stay: 0.3 days, p (gradient)=0.004 |
| Tchouta et al (146) | Adjusted OR for length of stay: 0.2 (SE: 0.05), p<0.001<br>No significant difference for complication rate |
| Park et al (149) | Multivariate analysis, shorter LOS by 0.9 days (+/-0.4), p=0.001 for HVC |
| Hollenbeck et al (135) | Long length of stay for HVC vs LVC: 7.8% vs 13.7%<br>Adjusted OR for long length of stay: 1.3 (1.0-1.6) |

HVC: High volume centre; LVC: Low volume centre; SD: Standard deviation

*2.3.4.1.2 Impact of Surgeon procedure volume*

Studies investigating the hospital volume relationship propose that the outcome of a procedure for lung cancer is likely to depend on how well that operation is performed which in turn is determined by the experience of the operating surgeon. (129,132)

Three studies (n=58,387 patients) were identified investigating the impact of surgeon procedure volume for patients undergoing lung cancer resections with mixed results presented in Table 2.10. (140,142,152)

The most recent study by Smith et al uses the SEER registry linked to Medicare to examine 2295 patients with Stage I NSCLC over the age of 65 undergoing a VATS procedure for lung cancer. (152) Although the authors do not report the cut-off points to define their surgeon volume tertiles, they conclude that patients undergoing VATS by high volume surgeons (HVS) experience improved overall and lung cancer specific survival when adjusted for patient and surgical confounders. (Overall adjusted mortality for HVS (reference LVS): HR 0.70 (95% 0.58-0.84); Lung cancer specific adjusted mortality for HVS (reference LVS): HR 0.71 (95% CI 0.53-0.95)). In addition, they found that patients operated on by HVS had decreased odds of ICU admission (adjusted OR: 0.68 (95% CI 0.53-0.87)) or having a complication (adjusted OR 0.84 (95% CI 0.73-0.97) compared to low volume surgical groups (LVS). However, after adjustment for patient and surgical characteristics having a specific complication (including extrapulmonary, cardiovascular, thromboembolic, respiratory), receiving a transfusion or being admitted within 30 days was not significantly associated with surgeon volume.

In contrast Birmeyer et al and Hannan et al do not find that surgeon volume on its own is a significant predictor of mortality. (140,142) Hannan et al found that the adjusted mortality of

patients in the LVS group was 1.12% higher than in the HVS group but this did not reach statistical significance (p=0.08). (142) However, the correlation between hospital volume and surgeon volume is high (r=0.76, p0.0001). Birkmeyer additionally demonstrated a statistically insignificant association between surgeon volume and mortality with an adjusted odds for postoperative death for LVS of 1.24 (95% CI 1.08-1.44; reference HVS). (140) However, they go further to demonstrate that much of the observed association is contributed by hospital volume. When the OR is adjusted for hospital volume, significance is attenuated (adjusted OR of operative death for LVS: 1.16 (95% CI 0.99-1.36); reference HVC). They estimate that approximately one third of the effect of the association of surgical volume with mortality is attributable to hospital volume

.

**Table 2.10 Studies examining the impact of surgeon procedure volume in lung cancer resection patients**

| Study | Data source | Data year | Number of patients | Number of surgeons | Volume categories* | | Outcome<br>High volume surgeons (HVS) compared to low volume surgeons (LVS) |
|---|---|---|---|---|---|---|---|
| | | | | | Low | High | |
| Hannan et al<br>USA (142) | Admin | 1994-1997 | 6954 | 373 | 1-22 | >131 | Inpatient mortality rate for HVS vs LVS: 1.80% vs 2.56%<br>Relative risk adjusted inpatient mortality rate (reference HVS): 1.12 (p=0.08) |
| Birkmeyer et al<br>USA (140) | Admin | 1998-1999 | 24092 | 4178 | <7 | >17 | Adjusted OR of operative death with LVS: 1.24 (95% CI 1.08-1.44), reference HVS<br>Adjusted OR of operative death for LVS adjusted for hospital volume: 1.16 (95% CI 0.99-1.36), reference HVS |
| Smith et al<br>USA (152) | Admin | 2000-2010 | 2295 | 512 | NA | NA | Overall adjusted mortality for HVS (reference LVS): HR 0.70 (95% 0.58-0.84)<br>Lung cancer specific adjusted mortality for HVS (reference LVS): HR 0.71 (95% CI 0.53-0.95). |

*Number of procedures performed by a surgeon/year

*2.3.4.1.3 The impact of surgeon speciality*

Studies have noted not only the importance of the volume of procedures a surgeon conducts but also the specialist training of that surgeon. The impact of whether a surgeon is trained in general surgery (GS), cardiac surgery (CS) or thoracic surgery (TS) is the subject of four identified articles (n=119,495 patients) and summarised in Table 2.11. (153–156)

The method in which surgeons were designated a specialty differed between the studies. Surgeons that appeared on the American Board of Thoracic surgeons list and did not perform any cardiac procedures were designated thoracic surgeons in two studies. (153,155) Whereas Ellis et al split surgeons into three groups based on the percentage of their total case volume spent doing general thoracic surgery, cardiac surgery or any other type of surgery. (156) Finally, Martin- Ucar et al studied the impact of adding a speciality trained surgeon to the staff in a before and after, single institution study based in the UK. (154) In this study the authors report a threefold increase in resection rate in histologically confirmed NSCLC cases (12.2% to 23.4%, $p<0.001$). In addition, the resections that were being done were more complex. However, this increase in resection rate did not result in improved operative mortality or 1- or 5-year survival rates.

Three studies found that resections performed by thoracic surgeons were associated with improved survival. (153,155,156) Goodney et al report a reduction in adjusted operative mortality of 2% for TS compared to GS ($p<0.001$). (153) Ellis et al report that the odds of in hospital death are increased by 47% for resections performed by GS compared to operations by TS (In hospital mortality risk (OR): GS: 1.47 (95% CI: 1.14-1.90), $p=0.003$)). (156) Finally, Farjah et al demonstrate that operations by TS have a 17% and 9% lower hazard of death compared with operations by GS and CS patients, respectively, after adjusting for

patient and disease characteristics. (155) Adjusting for hospital features as well resulted in a reduction of 11% for TS compared to GS, but differences between GTS and CTS or CTS and GS were no longer significant (adjusted HR of death for GS (0.89 (0.82-0.97), reference TS).

Two studies examined the hypothesis that the difference found in mortality and morbidity rates with CTS compared to GS is contributed by the completeness of intraoperative oncological staging (155,156).

Ellis et al examined the NIS database and found TS performed lymphadenectomy with lung resection in 72.8% of patients compared to GS (55.1%) and CS (54.1%), $p<0.0001$). (156) The authors also examine the impact of case volume and found that surgeons that had greater case volumes were more likely to perform a lymphadenectomy. When thoracic surgical case volume was introduced into the adjusted model the effect of speciality was no longer significant highlighting the importance of case volume.

In addition to higher lymphadenectomy rates for TS, Farjah et al proposed that the higher use of PET and minimally invasive procedures conducted by TS compared to CS and GS contribute to improved outcomes. (155)

**Table 2.11 The impact of surgeon speciality on patient outcomes**

| Study | Data source | Data year | Number of patients | Speciality designation | Outcome |
|---|---|---|---|---|---|
| Goodney et al<br>USA (153) | Admin | 1998-1999 | 25,545 | Board certification | Adjusted operative mortality: 7.6% for GS; 5.6% for TS; 5.8% for non-cardiac surgeons. P=0.001 |
| Martin-Ucar et al<br>UK (154) | Clinical | 1994-1999 | 2,891 | Before and after | Resection rate before vs after appointment of TS: 12.2% vs 23.4% (p<0.001)<br>No significant difference for in-hospital mortality or 1- and 5-year survival before and after appointment of CTS. |
| Ellis et al<br>USA (156) | Admin | 1998-2007 | 222,233 | Case mix | Lymphadenectomy rate: TS 72.8%, GS: 55%, CS: 54%, (p<0.0001)<br>Mediastinoscopy rate: TS: 15.8%; GS: 10.9%, CS: 9.6% (p<0.0001)<br>In-hospital mortality odds (OR): GS: 1.47 (95% CI 1.14-1.90), p=0.003); CS: 1.50 (95% CI: 1.18-1.91), p<0.001. (reference TS)<br>Risk of complications (OR): GS: 1.16 (95% CI 1.00-1.35), p=0.04, (reference TS). |
| Farjah et al<br>USA (155) | Admin | 1992-2002 | 19,745 | Board certification | Use of PET: TS: 36%; GS: 26%, CS: 26%, p=0.005)<br>Lymphadenectomy rate: TS: 33%; GS: 11%; CS: 22%), p<0.001.<br>Adjusted HR of death for GS: 0.89 (95% CI 0.82-0.97), reference TS<br>HR for death did not vary significantly for CS vs GS or TS vs CS.<br>Adjusted operative mortality, tracheostomy, reoperation, LOS, discharge to institutional care facility and readmission did not vary significantly by surgical speciality. |

GS: General surgeon; TS: Thoracic surgeon; CTS: Cardiothoracic surgeon

*2.3.4.1.4 The impact of hospital teaching status*

Four studies (n=84,340 patients) explore the hypothesis that the teaching status of an institution significantly affects mortality in lung cancer resection patients with differing results. (133,134,141,157)

The definition of what constitutes a teaching hospital varied and is shown in Table 2.12. Three showed that teaching status positively influenced survival with the remaining study showing no significant difference. (134,141,157)

In 2008, Meguid et al (n=47,364) published results from examination of the NIS database revealing that the odds of death were reduced by 17% in hospitals with a teaching status (OR: 0.83 (95% CI: 0.73-0.93), p=0.002. (157) This was corroborated by Cheung and colleagues the following year who showed a reduction in 30-day mortality by 1.5% ($p<0.001$) favouring teaching hospitals. (141) They also demonstrated similar reductions for longer term outcomes (90-day mortality for TH vs NTH: 6.8% vs 3.8%, $p<0.001$; 5-year mortality: 63.9% vs 59.2%). In contrast a study conducted in Finland using data from national registries (n=4878) found that surgery conducted in a university hospital was not significantly associated with in hospital mortality in multivariate analysis. (134) However, it was a significant positive predictor of cancer survival and overall survival. A Canadian study of 2698 patients showed no significant association with short- or long-term mortality rates. (133)

**Table 2.12 Studies examining the impact of hospital teaching status**

| Study | Data source | Data year | Number of patients | Number of hospitals | Definition of teaching status | Outcome |
|---|---|---|---|---|---|---|
| Simunovic et al Canada (133) | Admin | 1990-1993 | 2698 | 67 | Hospital affiliated with a medical school | Adjusted odds for operative death for NTH: OR 1.4 (95% CI 0.8-2.5), p=0.27, reference TH<br>Adjusted odds for long term survival for NTH: OR 1.1 (95% CI 1.0-1.3), p=0.10, reference TH |
| Cheung et al USA (141) | Admin | 1998-2002 | 13,469 | 190 | Recognition as a teaching institution by Association of American Colleges | 30-day mortality rate for NTH vs TH: 2.6% vs 1.1%, p<0.001<br>90-day mortality rate for NTH vs TH: 6.8% vs 3.8%, p<0.001<br>5-year mortality rate for NTH vs TH: 63.9% vs 59.2%, p=0.005.<br>Mean survival time for NTH vs TH: 40.5 months vs 47.1 months |
| Meguid et al USA (157) | Admin | 1998-2004 | 46,951 | 3210 | Hospitals that have residency training approval, belong to the Council of Teaching Hospitals or have a ratio of no more than 4:1 bed to WTE interns/residents. | In hospital death for NTH vs TH: 4.0% vs 3.2%, p<0.001<br>Adjusted odds of death for TH: 0.83 (0.73-0.93), p=0.002, reference NTH |
| Sioris et al Finland (134) | Admin | 1998-2002 | 4878 | 26 | Tertiary hospital responsible for training of medical students and specialists in medicine. | 30-day mortality rate was not significantly associated with hospital university status<br>Adjusted odds of cancer related death in non-university hospitals: OR 1.3 (1.1-1.5), p=0.01, reference university hospital<br>Adjusted odds of overall survival in non-university hospitals: OR 1.3 (1.1-1.5), p=0.01, reference university hospital |

NTH: Non-teaching hospital; TH: Teaching hospital; OR: Odds ratio; WTE: whole time equivalent

*2.3.4.1.5 The impact of a specialist centre*

The influence of a specialist setting on patient outcomes is examined by ten studies (n=607,215 patients) and summarised in Table 2.13. (136,151,158–165) Specialist centres were defined as 1.) Surgical centres 2.) Centres providing anticancer treatment and 3.) Centres designated as comprehensive cancer centres by the National Cancer Institute in the USA. Four studies examined mortality (136,161–163,165) with two showing improved survival rates favouring specialist centres. (161,163). All but one study (136) found improved treatment rates.

Four (151,158–160) of the five (151,158–160,162) UK based studies used NLCA data in cross sectional epidemiological studies to examine the impact of surgical centres. Firstly, Rich et al found that after adjustment for patient factors, patients with NSCLC who are first seen in a thoracic surgical centre are 50% more likely to have surgery than those first seen in a non-surgical centre. (158) This finding is supported subsequently by Lau et al who found the resection rate in hospitals where surgeons are based are 8.4% higher than in peripheral hospitals ($p<0.001$). (160) In addition, Khakwani et al report similar results using data over four years (2008-2012), including 95,818 patients. (159) They find that the odds of a surgical resection are increased by approximately 37% for patients first seen in a centre where thoracic surgeons are based compared to non-surgical centres (OR: 1.37 (95% CI 1.29-1.45)). Stewart et al corroborates these findings by demonstrating that patients were more likely to receive any therapy if first seen in a centre offering speciality treatment facilities after clustering for regional network and adjusting for patient and organisational factors compared no speciality treatment facilities (surgery RRR 1.80; chemotherapy RRR 1.81; radiotherapy RRR 1.47). (151)

Two surgical centre studies did not find a significant improvement in surgical resection rates or survival. (136,161) Firstly, Li et al reported that being treated in a cardiothoracic centre did not significantly improve treatment or five-year survival rates. (136) However, centres which were categorised as university affiliated centres or specialist cancer centres had significantly improved odds of receiving treatment ((OR 1.72 (95% CI 1.06-2.80), $p<0.05$). Secondly, Bendzsak et al used Canadian administrative data to study patient outcomes before and after the implementation of a policy to regionalise surgery to fourteen designated hospitals that have the following resources: 1.) On site certified specialist thoracic surgeons 2.) dedicated thoracic unit 3.) affiliation with a cancer centre 4.) minimum surgical volumes. (161) The policy did not result in an improvement in patient outcomes (operative mortality, resection rate, complication rate) beyond those that were already occurring over time.

Three studies examined the impact of being treated in a hospital that are designated cancer centres. (163–165) Sher et al categorise centres into three groups: Academic/research program, comprehensive community cancer program and community cancer programs. (164) The first two categories require a case load of a minimum of 500 new cancer cases per year, but the academic centre group must additionally have at least four postgraduate medical education programs including internal medicine and surgery. The community cancer program treats between 100-500 cases per year. The authors explored the US National Cancer Database to investigate treatment patterns in Stage IIIA NSCLC. They found that patients first seen in academic centres were more likely to receive surgery and receive preoperative therapy than those in community cancer centres as well as those in comprehensive community cancer centres after adjusting for patient, clinical and geographic factors. The volume of the institution was not a significant determinant of treatment receipt. Similarly, the impact of National Cancer Institute designated cancer centres (NCICCCs) in the State of Los Angeles

were studied by Wolfson et al. (163) They demonstrated that patients managed at such institutions had a higher 5 year over survival (adjusted 5-year survival if first seen in a NCICCC vs non NCICCC: 27.7% vs 16.5%, $p<0.001$). They estimate that for those in the non NCICCCs institution were 40% more at risk of dying than those in the NCICCCs at any point during the study (HR 0.73 (95% CI 1.3-1.6), $p<0.001$).

**Table 2.13 Studies examining the impact of lung cancer patients treated at a specialist centre**

| Study | Data source | Data year | Number | Definition of specialist centre | Outcome |
|---|---|---|---|---|---|
| Rich<br>UK (158) | Admin | 2004-2008 | 33,964 | Surgical centre | Odds of receiving surgical treatment in a surgical centre: OR 1.51 (95% CI 1.16-1.97), reference non-surgical centre |
| Khakwani<br>UK (159) | Admin | 2008-2012 | 95,818 | Surgical centre | Odds of receiving surgical treatment in a surgical centre: OR 1.37 (95% CI 1.29-1.45), reference non-surgical centre |
| Lau<br>UK (160) | Admin | 2008-2009 | 46,615 | Surgical centre | Resection rate in a surgical centre vs non-surgical centre: 20% vs 11.6%, p<0.001 |
| Stewart<br>UK (151) | Admin | 2007-2011 | 109,079 | Provision of specialist anticancer treatment facilities | RRR for receipt of the following with availability of onsite surgical facilities (reference no speciality facilities):<br>- Surgery 1.80 (95% CI 1.42-2.28); Chemotherapy 1.81 (95% CI 1.45-2.26); Radiotherapy 1.47 (95% CI 1.20-1.80)<br>RRR for receipt of the following with availability of onsite chemotherapy facilities (reference no speciality facilities):<br>- Surgery 1.22 (95% CI 0.95-1.56); Chemotherapy: 1.39 (1.10-1.75); Radiotherapy 1.27 (1.05-1.53) |
| Bendzsak<br>Canada (161) | Admin | 2004-2012 | 16,641 | Surgical centre | Before and after regionalisation of care to surgical centres:<br>- Resection rate: 71% vs 89%<br>- Mortality rate: 4.1% vs 2.9%<br>Adjusted odds for death after regionalisation: 0.68 (95% CI 0.58-0.81), p<0.001 |
| Jack | Admin | 1995-1999 | 32,818 | Radiotherapy centre | Adjusted odds for being first seen in a radiotherapy centre for receipt of:<br>- Active treatment: OR 1.72 (95% CI 1.21-2.46), p=0.003 |

| | | | | | |
|---|---|---|---|---|---|
| UK (162) | | | | | - Radiotherapy: OR 1.86 (95% CI 1.28-2.71), p=0.001<br>- Chemotherapy: OR 1.38 (95% CI 1.06-1.80), p=0.008<br>Adjusted odds for being first seen in a radiotherapy centre for:<br>- 1-year survival: OR 1.20 (0.97-1.50), p=0.10<br>- 3-year survival: OR 1.18 (0.97-1.43), p=0.09 |
| Wolfson<br>USA (163) | Admin | 1998-2008 | 10,844 | NCICCC | Adjusted 5-year survival if first seen in a NCICCC vs non NCICCC: 27.7% vs 16.5%, p<0.001<br>Adjusted HR for mortality if first seen in a non NCICCC: 1.4 (95% CI 1.3-1.6), p<0.001, reference NCICCC |
| Li<br>Netherlands (136) | Admin | 1998-2003 | 5846 | Surgical unit/Specialist centre (university affiliated & cancer specialist hospitals) | Adjusted odds of receiving treatment for surgical centre: OR 0.73 (95% CI 0.47-1.14)<br>Adjusted odds of receiving treatment for specialist centre: OR 1.72 (1.06-2.80), p<0.05<br>Cumulative 5-year mortality for surgical centres: HR 0.73 (95% CI 0.53-1.01), reference non-surgical centre<br>Cumulative 5-year mortality for specialist centre: HR 1.26 (0.94-1.70), reference non-specialist centre. |
| Sher<br>USA (164) | Admin | 2003-2010 | 18,581 | Academic centres vs Comprehensive CCC vs CCC | Adjusted odds of receipt of surgery for comprehensive CCC: OR 0.65 (95% CI 0.54-0.78), reference academic centre<br>Adjusted odds of receipt of surgery for CCC: OR 0.48 (95% CI 0.38-0.60), reference academic centre |
| Shulman<br>USA (165) | Admin | 2005-2012 | 252.392 | NCICCC vs Comprehensive CCC vs Academic centre vs CCC | Adjusted HR (95% CI) for: NCI CCC: 0.83 (0.80-0.88); Comprehensive community: 1.07 (1.05-1.09); community: 1.41 (1.11-1.17) |

NCICCC: National Cancer Institute designated Comprehensive Cancer Centre; CCC: Community Cancer Centre OR: Odds ratio; HR: Hazard ratio

*2.3.4.1.6 Site of care*

This section recognises the importance of the setting that treatment is delivered. Khakwani et al demonstrated that centres with the largest catchment populations were unable to provide equal access to surgery for patients seen at non-surgical centres they serve, compared with patients presenting to their own. (159) This finding suggests that the distance to specialist centres may be a barrier to accessing specialist care.

Eight studies (n=99,651 patients) investigated the effects of distance (n=7) or site of care (n=1) in the treatment of lung cancer. (166–171) Studied outcomes included treatment rates (n=5), mortality (n=4) and timeliness of care (n=3). Two studies (167,172) used clinical data with relatively small numbers of included patients with six using administrative datasets (166,168,170,171,173,174). There were variable measures of distance/travel burden with arbitrarily defined cut off values shown in Table 2.14.

Three studies report hazard ratios examining the effect of increasing distance on survival. (166,168,174) One found no significant association with distance. (168) Campbell et al found a modest increase in risk of death with increasing distance from the nearest hospital (HR for death after diagnosis for living ≥38km from hospital, reference ≤5km: 1.09 (1.01-1.18), p=0.024). (174) Additionally, Tracey et al showed that the risk of death for those first seen in a specialist hospital and live >100km is 36% less than those first seen in a specialist hospital but live 0-39.9km. (166) When a post hoc analysis was conducted for patients that did not have a resection, the risk of death was not significantly different for specialist or general hospitals. Therefore, the authors conclude that the two main factors that influenced survival was attendance at a specialist hospital and having a resection regardless of distance.

The effect of distance on treatment rates is examined by five studies. (166,167,170,171,173) Tracy et al is the only study that demonstrate that that the resection rate is higher in the group living closer in their study using Australian Cancer Registry data of 23,871 patients with NSCLC. (166) However, when split into those that were first seen in a specialist hospital or general hospital, resection rates between these groups did not significant vary. In fact, those that were first seen in a specialist hospital, the resection rate was higher in the group of patients living >100km from the hospital.

Timeliness of care is investigated by three studies. (167,171,172) Gotfrit et al and Verma et al report significant reductions in time delays. (167,172) Gotfrit et al quote a reduction in time from first consult to treatment by 16 days (p=0.012) and 12 days for diagnosis to treatment (p=0.034) for patients living <60 min drive vs >60min drive. (167) Verma and colleagues conducted a small prospective cohort study of 252 patients investigating the impact of living in a rural vs urban location. (172) They report that the difference in median time delay from first symptoms to treatment was 50 days favouring patients that lived in an urban location. Conversely Scoggins et al demonstrate a time delay of 0.82 days per driving hour or 4.84 days per driving mile from time to first treatment which was non-significant. (171)

Several of the articles conclude that other factors are likely to play a significant role in the association. This is demonstrated by Crawford et al. (173) They found that when examining travel distance with the likelihood of receiving active or surgical treatment that there was no significant difference with those that lived the closest to those that lived the farthest, adjusting for age and sex. However, when studied by deprivation index, those that lived the furthest and in the most deprived areas were least likely to have active treatment (OR: 0.55 (95% CI 0.46-0.67) or thoracic surgery for NSCLC (0.55 (95% CI 0.39-0.76) compared to those who lived the closest and least deprived.

**Table 2.14 Studies examining the impact of site of care**

| Study | Data source | Data year | Number | Site of care variable used | Outcome |
|---|---|---|---|---|---|
| Tracy<br><br>Australia (166) | Admin | 2000-2008 | 23,871 | 0-39.9km vs >100km | Resection rate for >100km vs 0-39.9km: 49.4% (45.8-53.1) vs 62.5% (60.3-64.4)<br><br>HR for death for (reference first seen in specialist hospital 0-39.9km)<br><br>- first seen in general hospital>100 km: 1.82 (95% CI 1.55-2.13)<br>- first seen in specialist hospital>100km: 0.64 (95% CI 0.51-0.81) |
| Gotfrit<br><br>Canada (167) | Clinical | 2009-2012 | 514 | <60 min drive vs >60 min drive | Rate of receipt of systemic therapy for <60 min drive vs >60 min drive: 55% vs 53%, p=0.72<br><br>Median overall survival for <60 min drive vs >60 min drive (months): 7.4 vs 8, p=0.055<br><br>Time from first consult to first treatment (days): 51 vs 67, p=0.012<br><br>Time from diagnosis to treatment (days): 22 vs 35 days, p=0.034<br><br>Distance not significant predictor of treatment receipt in multivariate analysis |
| Scoggins<br><br>USA (171) | Admin | 1997-2003 | 1,787 | Linear model for driving distance (miles) and driving time (hour) from home to PCP | Adjusted OR for likelihood of receipt of treatment for increasing driving time to PCP: OR 0.99, p=0.93<br><br>Adjusted OR for likelihood of receipt of treatment for increasing driving distance to PCP: OR 0.97, p=0.90<br><br>Adjusted co-efficient for increasing time to first treatment and increasing driving time to PCP: 0.82, p=0.843<br><br>Adjusted co-efficient for increasing time to first treatment and increasing driving distance to PCP: 4.84, p=0.54 |
| Jones | Admin | 1994- | 34,923 | Linear model of | Adjusted HR for increasing travel time to hospital (min): 0.998 (0.998-0.999) |

| | | | | | |
|---|---|---|---|---|---|
| UK (168) | | 2002 | | travel time | Adjusted HR for increasing distance (km) to nearest cancer centre: 1.000 (0.998-1.002) |
| Crawford<br>UK (173) | Admin | 1992-2002 | 34,923 | Quartiles for travel time (min): ≤7; 7.1-10.90;10.91-15.48:≥15.49 | Adjusted OR for active treatment for furthest hospital, reference closest: 1.01 (95% CI 0.95-1.08)<br>Adjusted OR for operation for furthest surgical centre, reference closest: 0.91 (95% CI 0.82-1.01)<br>Adjusted OR for chemotherapy receipt for longest travel time, reference shortest: 1.12 (95% CI 0.95-1.32) |
| Campbell<br>UK (174) | Admin | 1991-1995 | 19,449 | Quintiles (km): ≤5; 6-13;14-23;24-37; ≥38. | One-year survival for closest vs furthest (%): 21.7 vs 22.1, p=0.862.<br>Adjusted HR for furthest (reference closest): 1.09 (95% CI 1.01-1.18), p=0.024. |
| Verma<br>Australia (172) | Clinical | 2009-2012 | 252 | Urban vs rural | Median time from first symptoms to treatment urban vs rural (days): 125 (21-465) vs 170 (32-938), p=0.01 |
| Hopson<br>USA (170) | Admin | 2008-2012 | 3119 | Outpatient vs Physician office | Rate of receiving biologic therapy, Bevacizumab and platinum-based chemotherapy, biologic and chemotherapy, platinum-based drug only, platinum-based combination, other by SOC: no significant difference<br>Quality of care by SOC: No significant difference. |

PCP: Primary care provider; SOC: Site of care; HR: Hazard ratio; OR: Odds ratio

*2.3.4.1.7 Impact of specialist staff*

An aspect of specialist care that was featured in six studies (n=192,336 patients), is access to specialist staff (Table 2.15). (151,160,175,176) These studies hypothesised that patients seen by specialist providers of lung cancer care achieve better patient outcomes and reported significant results.

All studies demonstrated improved treatment rates. Ganti et al reported that the rate of cancer directed therapy in those seen by a specialist was 54% higher than those that did not see a cancer specialist (p=0.01). (175) Similarly, Erridge et al estimated that those who were not seen by a specialist were 47% less likely to receive radiotherapy than those that were (p<0.001). (176) Thirdly, Lau et al demonstrated that input of thoracic surgeons provided by attendance at more than two thirds of multidisciplinary (MDT) management meetings improved resection rates by 2.4% (12% vs 14.6%, p=0.046). (160)

Three studies emphasise the positive impact of the lung cancer specialist nurse (LCNS) or nurse navigator. (151,177,178) Stewart et al showed that patients that had an assessment by an LCNS were approximately twice as likely to receive surgery or chemotherapy (RRR for receipt of therapy compare to not being assessed: surgery RRR 1.98 (95% CI 1.11-3.53);chemotherapy: RRR 2.18 (95% CI 1.24-3.82)) and radiotherapy: RRR 1.84 (95% CI 1.17-2.87)), after adjustment for patient/organisational factors and clustered by regional network. (151) Additionally, early LCNS input was associated with a greater likelihood of receiving anti-cancer treatment compared to an assessment after diagnosis for all three therapy groups, with the greatest effect seen for surgery (RRR: 1.85 (95% CI 1.63-2.11).

Integral to the role of LCNS is assistance with navigating the health system. In North America/Canada, this role is encompassed by a ‘nurse navigator’. Two before and after

studies investigated the impact of the nurse navigator. (177,178) Zibrik et al examined 408 stage IIIB/IV NSCLC patients in Vancouver. (177) Findings revealed significant improvements in receipt of anticancer therapy and timeliness of care. A significant reduction in time from referral to systemic therapy (10 days) and radiotherapy (6.5 days) was shown. Kunos et al demonstrate similar results with a reduction of 19 days from suspicion of cancer on CXR to receipt of treatment after the implementation of a nurse navigator. (178) It should be noted that analysis of the 'after' data in both studies occurred between three to five years after the 'before' data was collected.

**Table 2.15 Studies examining the impact of specialist staff**

| Study | Data source | Data year | Number | Outcome |
|---|---|---|---|---|
| Ganti USA (175) | Admin | 2007-2011 | 31,919 | Receipt of cancer directed therapy in patients seen by cancer specialist vs not: 92% vs 38%, p=0.01 |
| Erridge UK (176) | Admin | 1995 | 3855 | Receipt of radiotherapy in patients who were diagnosed by a specialist vs not: 40.4% vs 18.6%, p<0.01<br>Adjusted odds of receiving radiotherapy if not been seen by a specialist: OR: 0.47 (95% CI 0.38-0.57), p<0.001 |
| Lau UK (160) | Admin | 2008-2009 | 46,615 | Resection rate for cancer networks served by ≥2 thoracic surgeons vs not: 14.6% vs 12.0%, p=0.028<br>Resection rate for surgical attendance for >2/3rds of MDTM vs not: 14.4% vs 12%, p=0.046. |
| Stewart UK (151) | Admin | 2007-2011 | 109,079 | Adjusted RRR for receipt of therapy for LCNS assessment (reference: not assessed):<br>- Surgery RRR 1.98 (95% CI 1.11-3.53); Chemotherapy RRR 2.18 (95% CI 1.24-3.82); radiotherapy RRR 1.84 (95% CI 1.17-2.87)<br>Adjusted RRR for receipt of therapy LCNS assessment before/at diagnosis (reference after diagnosis):<br>- Surgery RRR 1.85 (1.63-2.11); Chemotherapy RRR: 1.27 (1.14-1.42); Radiotherapy RRR: 1.16 (1.05-1.28). |
| Zibrik Canada (177) | Admin | 2011 (before) and 2014 (after) | 408 (Stage IIIB/IV) | Systemic therapy rates before and after appointment of NN: 57% vs 69%, p=0.05<br>Radiotherapy rates before and after NN: 91%% vs 87%, p>0.05<br>EGFR testing rates before and after NN: 62% vs 91%, p<0.001<br>Time from referral to being seen by medical oncology before and after NN (days): 18 vs 15.5, p=0.11<br>Time from referral to being seen by radiotherapy oncologist before and after NN (days): 10 vs 8, p=0.005)<br>Time from referral to systemic therapy before and after NN (days): 48 vs 38, p<0.016<br>Time to referral to radiotherapy before and after NN (days): 18 vs 11.5, p=0.0016.<br>Time from referral to EGFR results before and after NN (days): 34 vs 20, p<0.001 |
| Kunos USA (178) | Clinical | 2009-2010 (before) 2011-2014 (after) | 460 | Time from suspicion of cancer on CXR and treatment before and after NN (days): 64 vs 45, p<0.001. |

OR: Odds ratio; MDTM: Multidisciplinary team meeting: RRR: relative risk ratio

*2.3.4.1.8 Staff workload*

Access to specialist staff consists of adequate provision of staffing numbers and time. The impact of staff workload on patient outcomes is examined by three studies (n=109,711 patients) that investigate three different professional groups: CT radiographers, surgeons and lung cancer specialist nurses. (151,179,180). The findings are summarised in Table 2.16.

One study investigated the effect of increasing staffing provision of CT radiographers by extending working hours and staff number. (179) This single centre before and after study in Canada ascertained changes in wait time and tumour stage migration in patients with a pathological diagnosis of NSCLC. They found that before increasing staffing provision there was a significant increase in tumour size (mean difference 0.67 cm, $p<0.0001$) and stage ($p<0.00001$) from initial image to biopsy. Whereas, after the intervention, the mean wait was reduced by 11.5 days and there was no statistically significant increase in tumour stage or size.

The second study examined the workload of surgeons undertaking pulmonary lobectomies for lung cancer patients in another single institution. (180) Thomas et al analysed the workload of six surgeons and the impact on 481 patients' mortality and morbidity. They showed that increased surgeon workload was an adverse predictor of complications (OR: 1.036, p=0.03) and length of stay (average increase of 0.16 days for each additional hour, 0=0.006) after adjusting for patient variables. This study adds to the literature on the complex relationship between hospital and surgeon volume on outcomes. The authors highlight the importance of assessing staff workload to gain a holistic picture of a centre's quality of care.

Finally, Stewart et al conducted a sub analysis of patients considered suitable for surgery in their interrogation of the NLCA dataset. (151) Patients that saw a LCNS with a caseload of

>250 patients/year were approximately one third less likely to have surgery compared to patients that were assessed by a LCNS with a case load of ≤150 patients/year (RRR 0.71 (95% CI 0.51-0.97)).

**Table 2.16 Studies examining the impact of staff workload**

| Study | Data source | Data year | Number | Staff role studied | Outcome |
|---|---|---|---|---|---|
| Byrne<br>Canada (179) | Clinical | 2009-2011 | 151 | CT radiographer | Mean wait to CT: 19 days to 7.2 days |
| Thomas<br>USA (180) | Clinical | 2008-2009 | 481 | Surgeon | Adjusted odds for risk of complications by total number of operative hours/days: OR 1.036, p=0.03<br>Length of stay: 0.16 days more per additional operative hour worked, p=0.006 |
| Stewart<br>UK (151) | Admin | 2007-2011 | 109,079 | LCNS | RRR for receiving surgery with LCNS caseloads in those suitable for surgery >250: 0.71 (95% CI: 0.51-0.97) compared to LCNS caseloads <150 |

RR: risk ratio; RRR: relative risk ratio; LCNS: lung cancer specialist nurse

2.3.4.2 Co-ordination of care

The optimal management of lung cancer involves the co-ordination of specialities that may be co-located. The searches on this theme identified thirty studies that include interventions to improve multidisciplinary management and pathway speed/efficiency. The following subthemes are explored below 1.) Multidisciplinary care 2.) Rapid diagnostic programmes 3.) Care co-ordination programmes.

*2.3.4.2.1 Multidisciplinary care*

Multidisciplinary team (MDT) management in lung cancer aims to improve the quality of cancer care, access to treatment and enhance co-ordination. There were 13 studies (n>20,577) that met the inclusion criteria, published between 2005 and 2018. (181–192) Studies were classified into two groups: those that examined the value to discussing management plans in a multidisciplinary meeting (MDTM) (Table 2.17) and studies that evaluated the impact of a multidisciplinary clinic (MDC) (Table 2.18).

2.3.4.2.1.1 Multidisciplinary team meeting (MDTM)

All 9 studies (n>19,232) included in this category were observational. (181–183,185,187–189,193,194) A multidisciplinary team meeting was defined as a meeting attended by a variety of health care professionals, meeting at least fortnightly to discuss the diagnosis and management of patients with suspected lung cancer. Eight studies examined survival as an outcome quoting a median survival time of 3.2-15.6 months for patients with no MDTM's vs 6.6-25.2 months for MDTM management. (181–183,185,186,188,189,194) Six papers considered at least one confounding factor in survival analyses. (181–183,186,188,189) Two showed that accounting for confounders rendered significant unadjusted analyses insignificant. (181,186)

Dillman et al studied patients at a large community hospital in a before and after study.(181) The observed 5-year survival rate was significantly different in the MDT group (19%) compared to the non MDT group (16%, p=0.012). However, when examined by stage, the difference seen between the MDT vs non-MDT group became insignificant (local disease=0.66; regional: p=0.45; distant p=0.51). The authors state that the influence of stage differences is likely to mediate much of the effect on survival.

Boxer et al found that discussion at MDT did not predict survival in a study examining 988 patients in South West Sydney in a cox regression model (OR: 1.0 (95% CI 0.86-1.17) adjusting for patient and tumour factors. (186)

The most recent three studies found significant findings. (182,183,188) In 2018 Stone et al studied 1197 cases in a prospective cohort study in a single institution and showed improved adjusted survival at one and two years but not at five. (182) Further results favouring MDTM discussion were demonstrated by Mitchell et al with an overall survival benefit of 5.5 months ($p<0.001$) and a 38% reduction in risk of death shown by Rogers et al in 2017 (HR for survival: 0.62 (95% CI 0.50-0.76), $p<0.01$).

Changes in treatment rates were observed in four studies (183,185,186,194) with three showing increased rates in the MDTM group Improvements in specific treatment categories varied across studies.(183,186,194) Mitchell et al demonstrated an increase in curative treatment rates (22.2% vs 44%, p=0.001) and active treatment rates (70.5% vs 81.6%, p-0004) in their study of 841 patients in the state of Victoria, Australia. (183) Boxer et al reported a positive influence on chemotherapy and radiotherapy receipt (but not for surgery) and Forrest et al showing an increase of 16% in chemotherapy rates but no significant difference in radiotherapy (curative or palliative intent) rates. (186,194)

The above described studies examined the impact of patients being discussed at the MDT meeting. Osarogiabon et al study the impact of decisions made at such meetings being actioned compared to patients where care was discordant to the discussed management plan. (189) In their single centre study of 376 patients 63% of patients received concordant care and this group had a shorter time to treatment (25 vs 14 days, $p<0.002$), improved stage adjusted overall survival (HR for survival for concordant care: 1.7, reference discordant care, $p=0.02$) and stage adjusted progression free survival (HR for survival for concordant care 1.4, reference discordant care, $p=0.04$).

**Table 2.17 Studies examining multidisciplinary team (MDT) meeting management on patient outcomes (No MDT management vs MDT management)**

| Study | Data source | Data year | N | Outcome |
|---|---|---|---|---|
| Dillman USA (181) | Admin | 1986-1991 (Before) 1992-1999 (After) | 1562 | 5-year survival rate: 16% (before) vs 19% (after), p=0.012<br>Median survival time (months): 11 (before) vs 13 (after), p=0.012 |
| Stone Australia (182) | Admin | 2006-2012 | 1197 | 5-year HR for death: HR 0.7 (95% CI 0.58-0.85), p0.0001, reference no MDT |
| Bydder Australia (185) | Clinical | 2006 | 98 | Radical RT/Chemo-RT: 6% vs 10%, p=0.318<br>Active treatment rate: 35% vs 52%, p=0.288<br>Chemotherapy rate: 29% vs 42%, p=0.141<br>Palliative RT: 35% vs 25%, p=0.152<br>Palliative care: 29% vs 23%, p=0.204<br>Median survival (days): 208 vs 237, p=0.048<br>1-year survival: 18% vs 33% |
| Boxer (193) Australia | Clinical | 2005-2008 | 988 | Treatment rate: 4% vs 13%, p<0.01<br>Surgical treatment rate: 13% vs 12%, p=0.84<br>RT rate: 33% vs 66%, p<0.001<br>Chemo rate: 29% vs 46%, p<0.001<br>Adjusted OR for receiving the following treatment for MDT discussion (reference no MDT discussion):<br>- RT: OR 2.64 (95% CI 1.96-3.56)<br>- Chemo: OR 1.30 (95% CI 1.01-1.84)<br>Median time to diagnosis to (days):<br>- Surgery: 50 vs 42, p=0.49<br>- RT (curative): 91 vs 106, p=0.65; RT (palliative): 89 vs 87, p=0.89<br>- Chemo (curative): 45 vs 45, p=0.97; Chemo (palliative) 44 vs 60, p=0.03<br>Odds for survival (reference no MDT discussion): OR: 1.0 (95% CI: 0.86-1.17) |

| | | | | |
|---|---|---|---|---|
| Mitchell Australia (183) | Admin | 2003 | 841 | Curative intent treatment rate: 22.2% vs 44%, p<0.001<br>Active treatment rate: 70.5% vs 81.6%, p=0.004<br>Overall survival (months) 5.5 vs 10.8, p<0.001<br>Survival (landmark analysis, months): 9.3vs 13.3, p<0.001 |
| Freeman USA (187) | Clinical | 2008-2012 | 13,254 | Time from diagnosis to treatment (days): 19 vs 32, p<0.0001 |
| Rogers Australia (188) | Admin | 2009-2012 | 593 | Risk of death for MDT discussion (reference no MDT discussion): Adjusted HR 0.62 (95% CI 0.50-0.76), p<0.01 |
| Forrest UK (194) | Clinical | 1997 (before)<br>2001 (after) | 323 | Chemo treatment rate: 7% vs 23%, p<0.001<br>Palliative care rate: 58% vs 44%, p=0.045<br>Radical RT rate: 5% vs 2%<br>Palliative RT rate: 30% vs 30%<br>Mortality rate (minimum 33 months follow-up): 99.1% vs 92.1%, p=0.011<br>Median survival (minimum 33 months follow-up, months): 3.2 vs 6.6, p<0.0001 |
| Osarogiabon USA (189) | Clinical | 2006-2009 | 376 | Those discussed at MDT meeting and plan not actioned: vs those discussed but plans actioned:<br>- Time to treatment (days): 25 vs 14, p<0.002<br>- Survival (years): 1.3 vs 2.1, p<0.004<br>- Progression free survival (years): 0.8 vs 1.3, p<0.02<br>- Unadjusted overall survival (reference discordant care): HR 1.8, p=0.004<br>- Unadjusted progression free survival (reference discordant care): HR 1.5, p0.02<br>- Stage adjusted overall survival (reference discordant care): 1.7, p=0.02<br>Stage adjusted progression free survival (reference discordant care): 1.4, p=0.04 |

MDT: Multidisciplinary team; RT: Radiotherapy; Chemo: Chemotherapy; HR: Hazard ratio

2.3.4.2.1.2 Multidisciplinary clinics (MDC)

Multidisciplinary clinics aim to provide a consistent and holistic approach to patient care. Four studies investigated this intervention shown in Table 2.18. (184,190–192)

Three studies examined timeliness of care with varying results. (184,191,192) Seek et al showed an improvement in median time from diagnosis to treatment (29.3 vs 18.76 days) in a single centre before and after study of a community hospital. (184) Friedman et al reported similar results (29.1 vs 19.6 days) when studying 220 Stage III lung cancer patients in their centres. (191) However, no significant differences were found between the groups from time of initial radiology to treatment.

Onukwugha et al also investigated Stage III NSCLC patients, examining MDC care in fourteen National Cancer Institute Community Cancer Centres in the USA. (192) They hypothesised that MDC's provides higher quality MDT care by more timely care. An MDC development assessment tool was used to categorise the level of MDC implementation into high, moderate and low across seven domains. These were 1.) Case planning 2.) Physician engagement 3.) Co-ordination of care 4.) Infrastructure 5.) Financial 6.) Clinical trials and 7.) Medical records. They found no significant difference between the group scoring high compared to the low group in time to treatment for any of the above domains. A positive finding was found for centres reporting high MDC care for the care co-ordination domain compared to the low group with increased odds of receiving multimodality treatment (OR 10.94 (95% CI 1.68-71.42), p=0.01).

Finally, Kedia et al was the only qualitative study included. (190) The authors researched 46 patients' experiences of MDC care, conducting focus groups with patients receiving care with and without the involvement of an MDC that was co-ordinated by a nurse navigator. Patients

report a good experience stating that MDT care was more patient centred, effective, efficient, timely, equitable and co-ordinated. Whereas standard care was perceived to have delays with an emphasis on poor communication.

**Table 2.18 Studies showing impact of multidisciplinary clinics (MDC) on patient outcomes**

| Study | Data source | Data year | N | Outcome |
|---|---|---|---|---|
| Seek<br>USA (184) | Clinical | 2004 | NA | Mean time from diagnosis to treatment (days) 29.3 vs 18.76 |
| Kedia<br>USA (190) | Qualitative | 2013-2014 | 46 | Perceived benefits of MDC compared to standard care: patient centred, effective, safe, efficient, improved timeliness/equitable care/co-ordination<br>Perceived negative aspects of standard care: poor communication amongst physicians, delays, mistreatment, insensitive communication about illness |
| Friedman<br>USA (191) | Clinical | 2007-2012 | 220<br>(Stage III) | Median time from first contact with MDC/clinic to treatment (days): 29.09 vs 19.85, p=0.043<br>Median time from initial radiology to treatment (days): 54 (36-103) vs 61 (51.5-81.5), p=0.549<br>Staging of the mediastinum rate: 24.5% vs 57.7%, p<0.001<br>Unsuspected N2 disease rate: 36% vs 7.7%, p<0.001<br>Median overall survival (months): 14 vs 17, p=0.054 |
| Onukwugha<br>USA (192) | Clinical | 2007-2012 | 560<br>(Stage III) | Adjusted HR for high MDC implementation (3 categories: low (evolving MDC), moderate and high (excellent)) for (reference low):<br>- Time to treatment: HR 0.64 (95% CI 0.24-1.69)<br>Receipt of multimodality treatment: HR 10.94 (95% CI 1.68-71.42) |

HR: hazard Ratio; NR: Not reported; MDC: Multidisciplinary clinic

*2.3.4.2.2 Rapid diagnostic pathways (RDP)*

Timeliness of care was considered an important outcome in many of the included studies. It has been hypothesised that speedier care leads to better patient outcomes. The implementation of rapid or fast track systems to reduce delays for lung cancer patients were studied by six studies (n>779 patients) using clinical data shown in Table 2.19. (87,89,195–198) All six studied wait times and demonstrated a decrease however, not all reported or tested for statistical significance. A variety of time intervals were reported but the most common were time from diagnosis to treatment and time from referral to a specialist to diagnosis.

Murray et al was the only randomised control trial in this category. They enrolled patients with a possible diagnosis of lung cancer from three district general hospitals in the UK. and randomised patients to a two-stop pathway or standard care via an outpatient pathway. In the intervention arm patients received diagnostic tests on their first visit and then a treatment plan was developed at a MDT meeting three days later. (89) Patients in the intervention arm had a statistically significantly improved time from first presentation to treatment by four weeks (p=0.0025) and the chemotherapy rate was higher by 29% (p=0.03). There was no significant decrease in time from diagnosis to treatment. This was the only study that investigated survival as an outcome and found no significant difference in two-year survival between the groups.

Three observational studies reported a statistically significant decrease in pathway times. (87,195,196) Ezer et al examined the effect of a rapid investigation clinic (RIC) compared to patients undergoing standard care. (196) In this programme a pulmonary physician and nurse clinician assisted the co-ordination of care of patients with suspected lung cancer. A reduction in the median time from first contact with a physician to two points were reported favouring

the RIC arm: time to treatment from 78 to 65 days ($p<0.01$) and time to pathological diagnosis from 40 to 26 days ($p<0.01$).

Lal et al's retrospective before and after study in the UK showed significant decreases in time from referral to diagnosis, to first discussion at the MDTM and to decision to treat after the implementation of a fast track CT initiative. (87)

Finally, the remaining study that found statistically significant reductions in delays was a prospective observational study conducted in the Netherlands comparing rapid outpatient diagnostic programmes to a standard step wise approach. (195) Brocken et al showed a reduction in median time from first clinic to diagnosis by 7 days ($p<0.001$) and to management discussion by 11 days ($p<0.001$). This study was one of three in this category that examined patient reported outcomes. They showed a decrease in the first six weeks in emotional distress in the RDP group, with no such change in the control group. However, at three months there was no significant difference in emotional distress or quality of life scores between the groups. Murray et al and Lal et al reported patient experience was better in the intervention arm with patients feeling the standard pathway was too slow. (87,89)

**Table 2.19 Studies examining the impact of rapid diagnostic programmes (RDP)**

| Study | Data source | Data year | Components of intervention | N | Outcome |
|---|---|---|---|---|---|
| Brocken Netherlands (199) | Clinical | 2009 - 2010 | Following interventions within 2 days: PET-CT, respiratory physician consult, bronchoscopy, pulmonary function tests and results of cytology | 193 | Mean HADS score at day 1 and day 38 (SE):<br>- RDP malignant group: 14.5 (0.9) to 13.6 (1.2)<br>- Standard malignant group: 15.0 (1.1) to 17.6 (1.5)<br>EORTC QLQ-C30 score at day 1 and day 38 (SE): no significant changes for both groups.<br>Median time from first clinic to diagnosis for RDP vs no RDP (days): 7 vs 14, p<0.001<br>Median time from first clinic to discussion of management plan for RDP vs no RDP (days): 8 vs 19, p<0.001 |
| Ezer Canada (196) | Clinical | 2010 - 2011 | Nurse and clinician monitor investigation progress and assess co-ordination of care with psychological support. | 195 | Median time from first contact with physician to treatment for RDP vs no RDP (days (IQR)): 65 (46-92) vs 78 (49-119), p<0.01<br>Median time from first contact with physician to pathological diagnosis (days (IQR)) for RDP vs no RDP (days): 26 (14-42) vs 40 (16-68), p<0.01<br>Adjusted time interval to first treatment (days) for RDP group (reference no RDP): -24 (95% CI -35 to -12), p<0.01. |
| Murray UK (89) | Clinical | 2002 | Two stop pathway (max 2 weeks): CT scan and bronchoscopy/biopsy (same day)<br>Discussion at MDTM | 88 | Time from presentation to treatment for RDP vs no RDP (weeks): 3 vs 7, p=0.0025<br>Time from diagnosis to treatment for RDP vs no RDP: no difference.<br>Radical treatment rate for RDP vs no RDP: 43% vs 33%, p=no sig diff (value NR)<br>Chemotherapy treatment rate for RDP vs no RDP: 66% vs 37%, p=0.03<br>No significant difference for surgery or radiotherapy treatment rates<br>Role (p=0.02), social (p=0.03) and financial functioning (p=0.03) on QLQ: significantly worse in RDP group (figures NR)<br>QLQ: no significant difference in overall score<br>2-year survival rates for RDP vs no RDP: 40% vs 33%, p=0.7 |
| Lo Canada (197) | Clinical | 2004 - | New referral process and form; newly appointed | 52 | Median time from specialist consultation to CT for RDP vs no RDP (days): 3 vs 52 |

| | | | | | |
|---|---|---|---|---|---|
| | | 2005 | navigator; physician consult and spirometry on the same day; dedicated CT & bronchoscopy slots; MDT meeting; target wait times set; primary care education. | | Median time from CT to diagnosis for RDP vs no RDP (days): 6 vs 39<br>Median time from suspicion of lung cancer to diagnosis for RDP vs no RDP (days): 20 to 128 |
| Aasebo Norway (198) | Clinical | 2006 - 2010 | Lung package: automatic referral to physician on call by radiologist for suspicious imaging. Diagnostic workup max 4 weeks and time to start therapy 1 week from diagnosis. | 109 | Median time from referral to treatment for RDP vs no RDP (days): 16 vs 64<br>Median time from referral to surgery for RDP vs no RDP (days): 15 vs 26.5 |
| Lal UK (87) | Clinical | 2006 - 2007 | Fast track CT pathway: CT scan within 1 week of suspicious CXR. CT scans reviewed by chest physician, radiologist and LCNS and those with a suspicious CT scan are offered an urgent consult. | 142 | Median time from referral to diagnosis for RDP vs no RDP (days): 17 (IQR 13) vs 22 (IQR 14), p<0.001<br>Median time from referral to first discussion at MDTM for RDP vs no RDP (days): 22 (IQR 11) vs 32 (IQR 15), p<0.001<br>Median time from referral to decision to treat for RDP vs no RDP: 35 (IQR 23) vs 42 (IQR 30), p<0.05<br>Median time from referral to first treatment for RDP vs no RDP: 49 (IQR 36) vs 55 (IQR 36), p=0.095.<br>Proportion of patients who felt the process took too long for RDP vs no RDP: 6% vs 19%, p<0.05 |

HADS: Hospital Anxiety and Depression score; EORTC QLQ-C30: European Organisation for Research and Treatment of Cancer 30 item quality of life Questionnaire; QLQ: Quality of life questionnaire; MDTM: Multidisciplinary team meeting; NR: Not reported; LCNS: lung cancer nurse specialist

*2.3.4.2.3 Care Co-ordination programmes*

Care co-ordination programmes incorporate several changes aimed at impacting patient outcomes and were the focus for eight studies (n>11269 patients). (200–207) Such programmes combine interventions that have been investigated separately. These include initiatives to improve access to care, MDT aspect and timeliness of care. The assessed outcomes varied depending on the focus of the intervention shown in Table 2.20. Outcomes included time intervals, quality of life, treatment and survival rates.

In the USA, the emergence of diagnostic assessment programmes (DAPs) has been shown to improve patient care. The principle of a DAP is to "organise services centrally so that access to multi-disciplinary facilities are accessed in a single location with the aim of a rapid diagnosis and efficient treatment decision making". Alsamari et al evaluated the impact of DAPs in lung cancer on timeliness of care. They report a reduction from imaging to treatment by an average of 25 days (p=0.015) and 23 days to diagnosis (p=0.016). (200)

Similar findings were reported by a Canadian study that investigated the impact of introducing a nurse navigator, weekly MDT meetings and structured communication with primary care in a retrospective study of 113 patients. A decrease of 38 days and 25.5 days was found from the first abnormal image to treatment and to biopsy respectively. (207)

Survival was assessed by one study. (202) Bilfinger et al studied the impact of a programme where an MDT meeting was instituted with ancillary resources for facilitating referrals and appointments allowing for care to be centralised to one location. In adjusted propensity matched analyses, a significant reduction in mortality was reported for the intervention arm compared to standard care (HR: 0.65 (95% CI 0.54-0.77).

Improvements in treatment rates were reported by two studies, (203,205) with Lefresne et al reporting statistical significance (Radiotherapy receipt rate same day as consultation for CCP vs non CCP: 72% vs 41%, $p<0.001$). (203) Check et report increased treatment receipt rates for chemotherapy and radiotherapy (radiotherapy receipt rate for CCP vs no CCP: 51.1% vs 47.9%; chemotherapy receipt rate for CCP vs no CCP rate: 27.5% vs 33.8%) in the intervention arm but no significant different for receipt of surgery.

Finally, patient related outcomes were the focus of one study.(204) Smeltzer et al investigated the impact of a programme focused on improving communication and co-ordination of care through the implementation of MDT meetings, MDCs, and enhanced communication pathways. They showed no significant difference in quality of life scores.

**Table 2.20 Studies examining the impact of care co-ordination programmes (CCP)**

| Study | Data source | Data year | N | Components of CCP | Outcome |
|---|---|---|---|---|---|
| Alsamari USA (200) | Admin | 2005-2010 | 352 | Full time cancer care co-ordinator, creation of a 'Cancer Alert' code by radiologist to identify suspicious scans to alert the co-ordinator, computerised tracking system, weekly MDT nodule conference, hiring of a thoracic surgeon with an interest in lung cancer. | Median time from imaging to diagnosis for stage I for CCP vs non CCP (days): 87 vs 131, p=0.013<br>Median time from imaging to diagnosis for cancer found incidentally for CCP vs non CCP (days): 86 vs 114, p=0.031<br>Adjusted mean days from image to diagnosis for CCP vs non CCP: 53 vs 76, p=0.016<br>Adjusted mean days from image to treatment for CCP vs non CCP: 101 vs 126, p=0.015.<br>Adjusted mean days from diagnosis to treatment for CCP vs non CCP: 43 vs 46, p=0.60. |
| Leary UK (201) | Clinical | 2002-2004 | NR | Triage of referral, education and collaborative working with secretarial staff and Bed Management Team, patient information shared across the network; educational initiatives, increased availability of patient information | Mean time from decision to treat to treatment for CCP vs non CCP (days) 8 vs 38<br>Length of stay (days) for CCP vs non CCP (days): 6.5 vs 8. |
| Bilfinger USA (202) | Admin | 2002-2016 | 4271 | Patients see all specialities in one location with ancillary help to facilitate co-ordination of care. All patients discussed at an MDT meeting. | Propensity matched 5-year survival rates for CCP vs non CCP: 33.6% vs 23%, p<0.001<br>Propensity matched HR for survival for CCP (reference non CCP): 0.65 (95% CI 0.54-0.77) |
| Lefresne Canada (203) | Clinical | 2011-2012 | 219 (metastatic) | I hour consultation with radiation oncologist and nurse practitioner, discussion at an MDT meeting, additional radiation oncologist hired | Radiotherapy receipt rate same day as consultation for CCP vs non CCP: 72% vs 41%, p<0.001<br>Rate of patients double booked into oncologists' schedule for CCP vs non CCP: 13% vs 23%, p<0.001<br>Assessed for curative intent treatment for CCP vs no CCF: 43% vs 33%, p<0.001 |
| Smeltzer USA (204) | Admin | 2014-2015 | 526 | Focus groups to assess optimal care delivery pathways and barriers creation of a new benchmarked co-located multidisciplinary | QOL score for CCP vs no CCP: no significant difference |

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|---|---|---|---|---|---|
| | | | | clinic with infrastructure to implement benchmarked activities focusing on enhanced co-ordination and communication. | |
| Check USA (205) | Admin | 2004-2011 | 5786 | Co-ordinated information and referral networks | Radiotherapy receipt rate (no surgery) for CCP vs no CCP: 51.1% vs 47.9%<br>Chemotherapy receipt rate (no surgery) for CCP vs no CCP: 27.5% vs 33.8%<br>Surgery receipt rate: no significant difference |
| Common Canada (206) | Clinical | 2005-2016 | 133 | Nurse navigation, weekly MDT meetings, regular communication with primary care provider. | Median time from first abnormal image to biopsy for CCP vs no CCP: 36 vs 61.5 days, p<0.0001<br>Median time from first abnormal image to treatment for CCP vs no CCP: 80 vs 118 days, p<0.00072 |
| Hunnibell USA (207) | Admin | 2003 (before) 2010 (after) | NA | Care co-ordinator (CC) hired<br>Protocol established for radiology to alert CC of new cases<br>Electronic alert to primary care providers on films order with Fleichner recommendations<br>Creation of a pulmonary tumour board<br>Electronic referral process of lung biopsies<br>All lune biopsies conducted by interventional radiologists<br>Nurse hired to triage pulmonary referrals | Time from suspicion of lung cancer to treatment before and after appointment of NN: 136 days vs 55 days |

CCP: Care co-ordination programme; NR: Not reported; PSACCS: Picker System of Ambulatory Cancer Care Survey; SCNS-SF 34: The Supportive Care Needs Survey Short Form 34; MDT: Multidisciplinary team

2.3.4.3 Others: Patient led care and impact of technology-based interventions

Identified studies that did not fit into the above themes included patient led care, nurse led follow-up and technology-based interventions (Table 2.21 and Table 2.22).

Patient led interventions were examined by two studies (n=3125 patients) that did not find a positive association with patient outcomes. (208,209) Mills et al found that completing a QOL diary did not improve patient satisfaction with care, communication or discussion of patient problems. (208) Pollack et al found that patients who self-referred themselves to a service scored their satisfaction with physician communication lower than those that were referred via conventional referral pathways. (209) In addition, there were no significant differences between the groups for satisfaction with nursing care, co-ordination or responsiveness to care.

Moore et al conducted a randomised controlled trial examining nurse led follow-up of outpatients compared with standard care in 203 lung cancer patients that had completed their initial treatment. (210) In the intervention arm they found significantly improved scores for emotional functioning (p=0.03) and patient satisfaction as well as and less severe dyspnoea (p=0.03) amongst several assessed quality of life domains. There were no differences in survival or rates of progression between the groups.

**Table 2.21 Studies examining the impact of patient led care/nurse led follow-up**

| Study | Data source | Data year | N | Intervention | Outcome |
|---|---|---|---|---|---|
| Mills<br>UK (208) | Clinical | 2005-2007 | 115 | Patient held QOL diary | Mean change in score for diary vs standard care using TOI: -5.0 vs 0.4, p=0.14<br>Mean score for diary vs standard care using FACT-L: -6.3 vs 3.5, p=0.05 |
| Pollack<br>USA (209) | Admin | 2003-2005 | 3010 | Self-referral | Beta co-efficient for association between self-referral and physician communication satisfaction: -2.92 (95% CI -5.49 to 0.35).<br>No significant differences for self-referral vs standard care with experiences with nursing care, co-ordination or responsiveness of care. |
| Moore<br>UK (210) | Clinical | NR | 203 | Nurse led follow-up | Median ERTC QOL score for dyspnoea (IQR) at 3 months: 25 (16.7-41.7) vs 33.3 (25.0-58.3), p=0.03.<br>Median ERTC QOL score for emotional functioning at 12 months: (IQR): 91.7 (66.7-100) vs 66.7 (54.2-87.5), p=0.03.<br>Other domains not significant.<br>Patient satisfaction better in intervention group in all subscales at 3 months (organisation of care, information, personal experience of care, satisfaction of care, support overall). (p<0.005). 6 months (p=0.001) in first three domains. 12 months p<0.05 in first three domains.<br>Median survival for intervention vs usual care (months): 9.2 (95% CI: 6.2-12.1) vs 10.4 (7.6 -13.2), p=0.99 |

QOL: Quality of life; TOI: Trial Outcome index; FACT-L: Functional Assessment of Cancer Therapy-Lung; NR: Not reported; EORTC QOL: European Organisation for Research and Treatment of Cancer Quality of life

Telemedicine aimed at improving the efficiency of communication between health care professionals was the subject of three studies (n=566 patients). (211–213) Stevens et al demonstrated that video conferencing used in MDT meetings did not impact on treatment rates in a single site study in New Zealand of patients referred for radiotherapy. (212) However, Seeber et al showed that the implementation of video MDT at an oncology day centre in Austria resulted in a 40% increase in radiotherapy treatment rates (p=0.001). (213) However, similar significant improvements were not observed for receipt of chemotherapy.

The final study introduced bespoke technology-based support systems and assessed patient related outcomes. (211) One system involved automated delivery reports of clinically significant symptoms to clinical teams for further assessment. In addition, teams had access to graphical and longitudinal displays of symptom scores. The control group in this study simply monitored their symptoms weekly and discussed the results at scheduled appointments. They found no significant difference in overall symptom burden or health related quality of life. In fact, the patient satisfaction score was higher in the control group.

**Table 2.22 Studies examining the impact of technology-based interventions**

| Study | Data source | Data year | N | Intervention | Outcome |
|---|---|---|---|---|---|
| Yount<br>USA (211) | Clinical | NR | 253 | Technology based symptom monitoring and reporting | No significant differences in mean overall symptom burden adjusted for baseline<br>No significant difference in health-related quality of life<br>Patient satisfaction score higher in control group compared to interventional group, p<0.027. |
| Stevens<br>New Zealand (212) | Clinical | 2009 | 110 | Video MDT conference | For video vs standard group:<br>Proportion seen in RO clinic: 87% vs 87%, p=1.0<br>Proportion recommended curative intent RT in clinic: 23% vs 10%, p=0.11<br>Proportion recommended palliative intent RT in clinic: 55% vs 68%, p0.11<br>Median time from diagnosis to RT (days) 64 (IQR 23,86) vs 42 days (IQR 20,60), p=0.37. |
| Seeber<br>Austria (213) | Clinical | 2003-2011 | 203 | Video MDT conference | Radiotherapy rate for video vs standard care: 70% vs 30%, p=0.001<br>Chemotherapy rate for video vs standard care: figure NR, p0.415<br>Bisphosphonate rate for video vs standard care: figures NR, p=0.166 |

LC: lung cancer; RT: Radiotherapy; RO: Radiation oncology; NR: Not reported

2.3.4.4 Summary of results by outcome

Figures 2.7 a-c show a summary of the results by the two broad themes (co-ordination of care and specialist care) by the four main outcomes studied (survival, improved treatment rates and improved timeliness of care). These show that the majority of studies in both themes showed a positive association with all outcomes.

**Figure 2.7a: Outcome by theme: Survival**

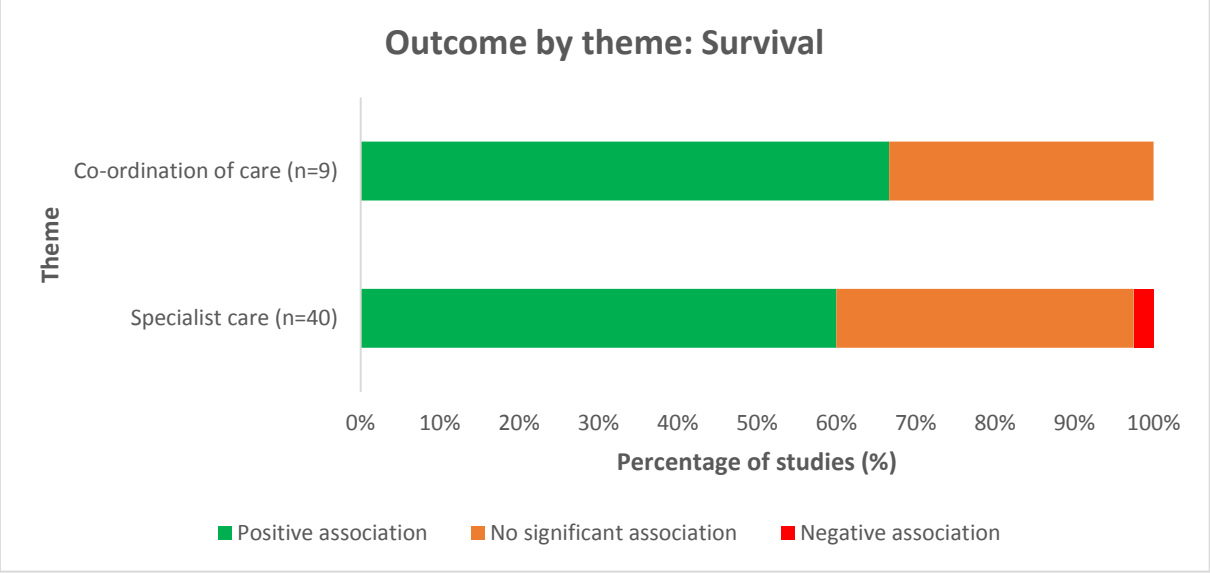



Figure 2.7b: Outcome by theme: Treatment rates

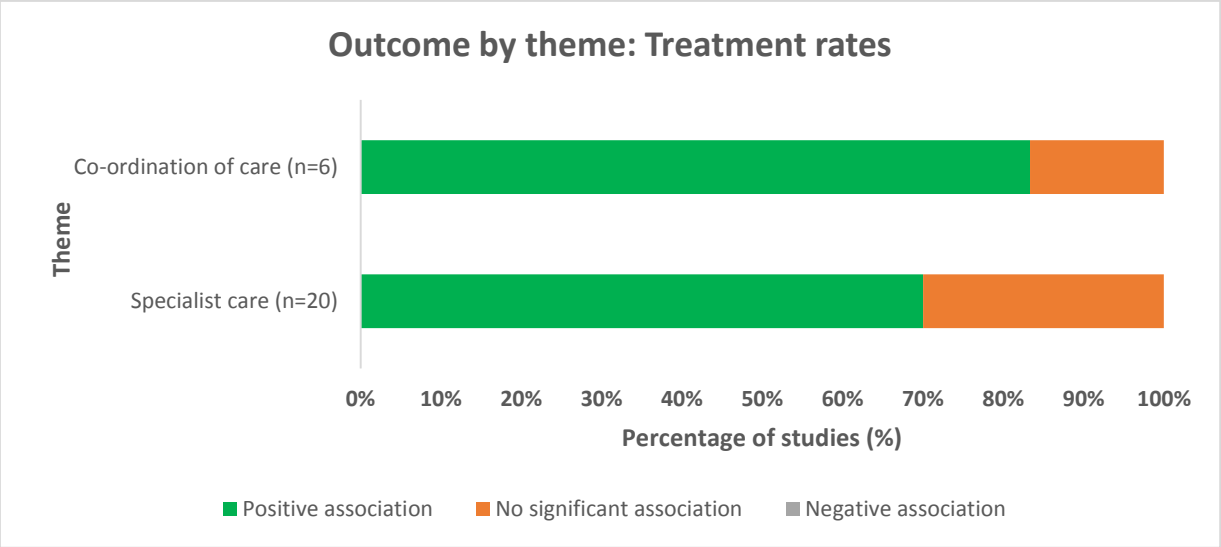
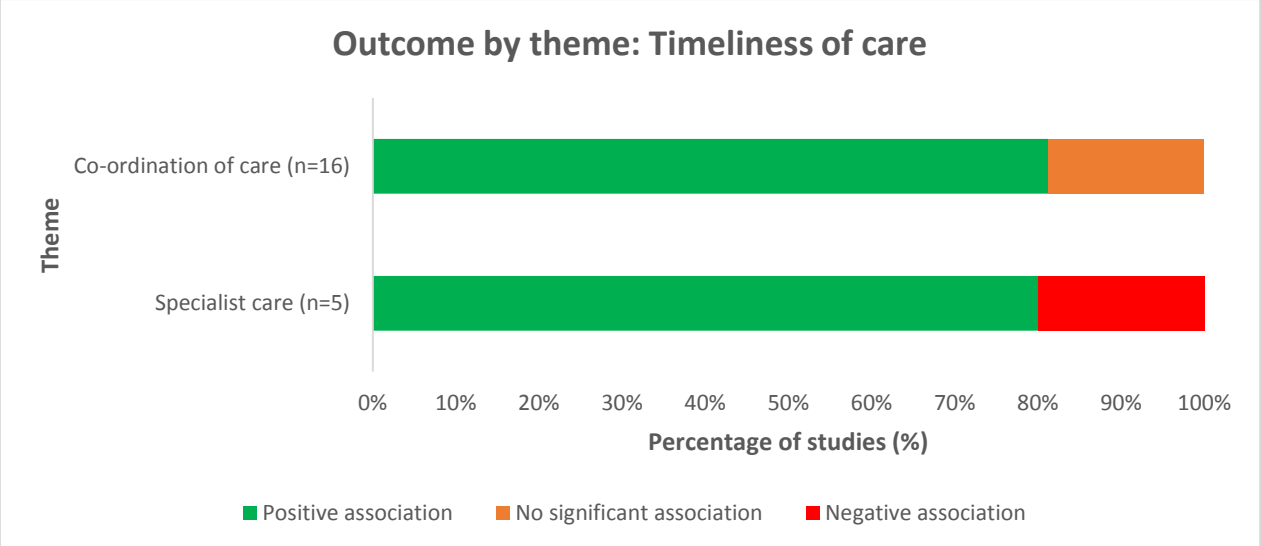


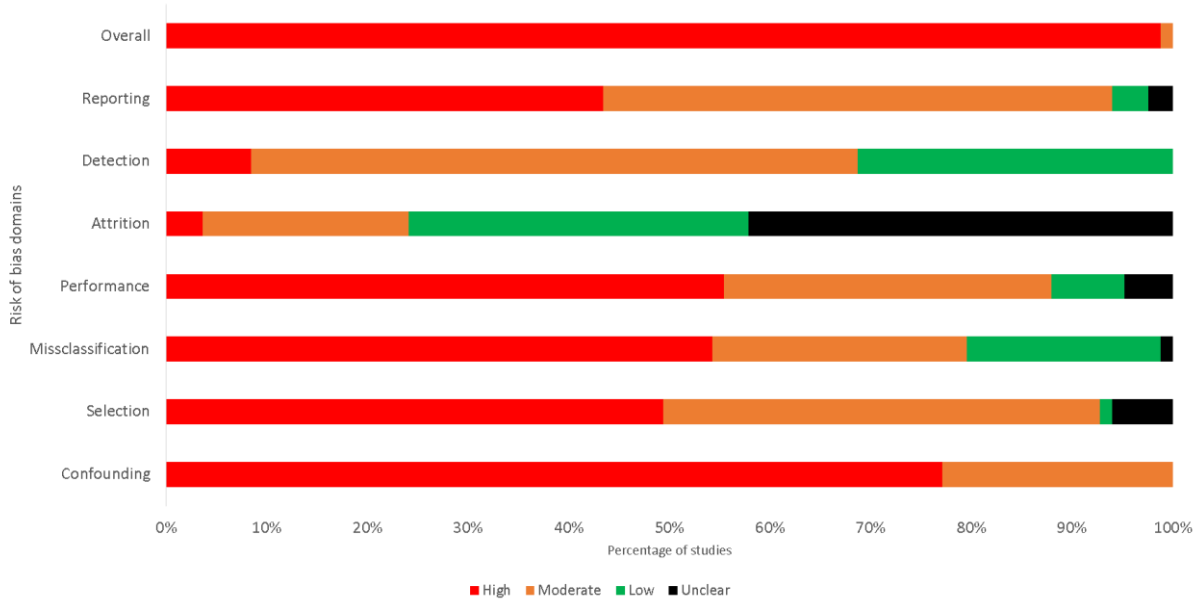

Figure 2.7c: Outcome by theme: Timeliness of care



## 2.3.5 Risk of Bias

Overall there was a high risk of bias across all studies (Figure 2.8). The majority of studies used large administrative data sets which led to issues with confounding, selection and performance bias. Contributing factors include difficulty controlling for known effect modifiers, isolating the studied intervention, lack of statistically accounting for the hierarchical nature of the data and inherent problems with recording clinical information on administrative databases, Details of attrition and reporting bias were unclear mainly due to poor reporting. Finally, arbitrary cut offs for groups led to high risk of bias for the misclassification domain

**Figure 2.8 Risk of bias for main review**

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# 2.4 Discussion

## 2.4.1 Introduction to discussion

The National Lung Cancer Audit (NLCA) show that there is variability in patient outcomes across the country that is in part due to geographical differences in the patient population. (214) This review presents evidence that the organisation of health care plays a significant role in influencing lung cancer outcomes.

At a time when change in the organisation of cancer services is being considered it is important that information is collated in a systematic way so that models of care that benefit patients can be adopted. In addition, improvements in efficiency and effectiveness of working is vital in an increasingly resource stretched National Health Service (NHS).

To my knowledge this is the first review that has synthesised the current evidence on organisational interventions in lung cancer linked to patient outcomes; it is comprehensive, including 84 papers and a total of 1,897,184 patients from ten countries.

In the following section the results of the findings are discussed in greater detail and the evidence is contextualised to a UK health system.

The studies included in the review fall into two main themes: specialist care and co-ordination of care.

## 2.4.2 Specialist care

### 2.4.2.1 What are the main findings?

The results show that the best outcomes are achieved in high procedure volume and specialist hospitals that provide specialised staff with dedicated time to deliver care to lung cancer patients. There is evidence to support improved survival, lower morbidity and increased treatment rates at these centres compared to non-specialised/low volume hospitals.

The section with the most studies (n=23) available examined the hospital volume-outcome relationship with conflicting outcomes. A trend for a modest positive association with survival is demonstrated for HVC. This is in keeping with the growing amount of evidence found in the scoping review that high volume hospitals undertaking procedures such as coronary artery bypass grafting, aortic valve replacement and oesphagectomy provide higher resection rates, shorter length of stay, improved survival, and lower readmission risk than low volume hospitals. (215–217) Luchenborg and Moller et al demonstrated that this relationship holds true despite the high-volume hospital group having an older, more co-morbid and deprived population. (139,148) They advocate that larger hospitals are more likely to take on riskier cases and the analyses are likely to underestimate the magnitude of favourable outcomes obtained by HVH due to statistical adjustment for patient features.

Nine of the 24 studies estimated the likelihood of death for early and late postoperative outcomes. (128–130,133,136,137,139,141,148) All demonstrated that there is a greater mortality reduction in HVC compared to LVC in the early post-operative period compared to late outcomes. This suggests that the management beyond the operation is likely to be important highlighting a common conclusion amongst the included studies: the studied

intervention is likely to be a proxy for an efficient lung cancer pathway resourced to deliver best practice.

2.4.2.2 Postulated reasons for how specialist care influences patient outcomes?

These results point to four main factors that are important in the association between specialist care and patient outcomes. These are: 1.) The infrastructure of the hospital 2.) Consistency of decision making 3.) The importance of equitable access to care and 4.) Education and networking opportunities.

*2.4.2.2.1 Hospital Infrastructure*

Each of the examined organisational factors are likely to be a proxy for the infrastructure of the treating institution; a finding replicated in studies of other cancer sites and other specialities. (218)

A systematic review comparing inpatient specialised stroke unit care with an alternative service reported a significant reduction in the likelihood of death by 17% ($p<0.05$), death/institutional care by 25% ($p<0.0001$) and death/dependency by 31% ($p<0.0001$).(219) This evidence led to the widespread establishment of stroke units and implementation into national guidelines. Early evaluation of stroke unit care found significant variation in patient outcomes still existed. (220) Rudd et al showed via audit data that less than half of hospitals that stated they had dedicated units reported having all five organisational characteristics that previous research literature identified as key features of a specialised stroke unit. This suggests that there was national pressure to provide specialist care without the additional allocated resources provided to support the local hospital infrastructure to achieve this aim. In 2004, a UK government directive stipulated that all stroke care should occur on a stroke unit

fulfilling resource criteria. Subsequently, data have demonstrated improvements in patient outcomes. (221)

In lung cancer, Alsamari et al showed that specialised care via diagnostic assessment programmes (DAP's) in the USA improved patient care. (200) Subsequently Honeiun et al investigated the organisational characteristics for the optimal DAP design via a mixed methods approach. (222) In keeping with the results of this review, the authors identified the following characteristics of the hospital infrastructure as being important: improved information systems, greater numbers of staff and co-ordinated care achieved through staff co-location and patient navigators.

*2.4.2.2.2 Consistent decision making*

Three findings from the included surgical studies suggest that consistent decision making in preoperative patient selection is more likely to occur in a specialist centre. Firstly, the difference in patient outcomes between specialist centres and non-specialist centres is sustained beyond the short term. This finding can be explained by the fact that in lung resections patients rarely die from complications from the surgery itself. (223) Long term survival is contributed by access to adjuvant therapies, quality of nursing/allied health input and hospital processes ensuring appropriate follow-up. (223) This demonstrates the importance of specialist multidisciplinary decision making that is likely to occur in specialist centres.

Secondly, Rich et al show that in the UK there was no difference in case mix between the surgical centre group and non-surgical centre group. (158) However, patients in the former group were more likely to have an operation. Consequently, it is likely that MDTs in such centres have the expertise and skills in optimal patient selection.

Finally, the American studies show the positive influence of specialist thoracic surgeons with a high procedure volume on patient outcomes. Such surgeons are more likely to operate in high volume centres. Birkmeyer et al report that the surgeon and hospital procedure volume contribute equally to the observed association with improved patient survival. (215) Consequently, it is likely that these hospitals have the specialist personnel, support and skills to make appropriate consistent decisions for lung cancer patients.

*2.4.2.2.3 Access to care*

Access to specialist care is vital if outcomes are to be improved. Evidence to support this hypothesis is that patients that are less deprived are seen in high volume specialist hospitals. Therefore, it may be the ability of these patients to access specialist hospitals that drives the favourable patient outcomes seen in specialist institutions.

The UK studies examining hospital volume-outcome association show that there is no difference in case mix between HVC and LVC. (139,148) However, several of the studies based in the USA report that LVC treat patients that have a higher overall risk of mortality, complications and prolonged length of stay. (128,141,144) The reasons contributing to this finding are likely to be multifactorial. One factor may be that this category of patients are from more deprived areas, with lower educational levels and less likely to have private insurance cover. This theory is supported by other studies. Crawford et al found that when investigating the influence of travel distance to hospital on outcomes that increasing distance to their hospital did not significantly influence treatment rates. (173) When studied distance was combined with deprivation index, lung cancer patients that lived in the furthest and a deprived area were approximately 50% less likely to receive active treatment compared to those living near and in the least deprived area. The importance of socioeconomic class is

additionally demonstrated by Ganti et al that show patients from a deprived area have a reduced chance of seeing a cancer specialist. (175)

Many of the studies do not adjust for social class as a confounding factor. This review provides evidence that it is likely to interact with organisational factors to impact patient outcomes though this relationship is poorly understood.

*2.4.2.2.4 Professional development*

All four studies examining differences in outcomes by surgical speciality found that specialist thoracic surgical training was associated with improved patient outcomes. (153–156) The authors propose that differences may not only be because of specialist surgical expertise but opportunities to keep practice up to date are likely to be more readily available in specialist or teaching hospitals. Hence the most innovative practice leading to better patient outcomes gets centred around these hospitals. In time, such institutions will attract better facilities, more experienced multidisciplinary staff and therefore more advanced working environment. Therefore, general hospitals are left with decreasing support and resources, exacerbating the disparity between the two hospital types.

2.4.2.3 What are the limitations of the evidence?

The above results need to be taken in the light of several limitations common to the included studies which will be discussed in the following section. These are: -1.) Use of administrative databases 2.) Challenges of quantitatively pooling data 3.) Biases 4.) Study population.

*2.4.2.3.1 Use of administrative databases*

55 studies (65%) utilised administrative databases. This has the advantage of including large numbers of cases but comes with inherent flaws. Firstly, it is retrospective in nature with

limited capacity to capture long term outcomes and important patient or tumour specific details such as stage, performance status and patient co-morbidities. In addition, the large number of cases increases the risk that statistically significant value is obtained by chance. A review collating the evidence on the hospital volume-outcome relationship recommend the use of a C statistic to assess the quality and performance of the statistical model used on the ability to discriminate between observed instances of death and survival. (224) Only two studies reported this statistic. (143,225)

*2.4.2.3.2 Challenges of quantitatively pooling the data*

Performing a quantitative synthesis of the data posed four main challenges. Firstly, the category likely to be amenable to meta-analysis due to having the greatest number of studies was those investigating the hospital-volume relationship. However, Table 2.8 shows that each study reported differing volume cut offs to define HVC and LVC making comparison difficult. The rationale for the cut off values were generally poorly reported in the study. Stukenborg et al highlight that comparing odd ratio values across arbitrary volume categories is problematic. In order to determine cut of values methodologically the authors advocate a technique called restricted spline regression. This uses multiple data points to estimate the association between volume and mortality. This method was not adopted by papers published subsequent to this finding.

Furthermore, the variability in cut off values between countries makes comparison difficult to contextualise to a UK setting. Pezzi et al define HVHs as conducting over 90 procedures per year. (130) This would be considered very low by UK and European standards; (139) Moller et al used a cut off of 190 procedures per year in their UK based study for a HVC. In addition, the number of procedures conducted by each hospital within the category varied widely

between studies. For example, the authors in the study by Cheung et al state that sixteen hospitals in the LVC category performed an average of one or fewer lung resections per year and 23 performed only one resection in the entire four year study period. (141)

Secondly, risk adjustment for confounding factors was variable across the studies. Stukenborg et al highlight the variability in statistical techniques used to account for co-morbidity; an important patient characteristic known to influence lung cancer mortality risk. (143) The focus of the study by Stukenborg et al was to compare three methods of co-morbidity risk adjustment. These were adjustment using a present at admission diagnoses technique, the Elixhauser method and an adaptation of the Charlson index. They found that each model yielded different mortality risk outcomes depending on the method used. Therefore, emphasising the importance of assessing the accuracy of risk adjustment when interpreting and combining results from different studies.

Thirdly, all the studies used a logistic regression model taking into account patient level data and hospital level data (procedure volume). However, only four studies explicitly took into account the hierarchical nature of the data. (128,131,141,148) It is only possible to understand the effect of hospital volume rather than the effect of a hospital by statistically acknowledging the multi-level structure of the data. Urbach et al show that models that do and do not incorporate multi-level modelling produce different results. (147) Models that fail to cluster for hospitals tend to overestimate the effect of the intervention and therefore any comparison with other studies should be interpreted with caution.

Lastly, inconsistency in definition of the categories was found. The definition of teaching status varied amongst studies shown in Table 2.12. In the USA, a ‘major’ teaching hospital was defined as 1.) A hospital on the council of teaching hospitals of the Association of

American Medical Colleges. 2.) Had a specified ratio of beds to interns/residents 3.) Affiliated with a medical school. (157) Other hospitals classed as ‘teaching’ did not fulfil these criteria but were assessed in the same category.

*2.4.2.3.3 Biases*

It is notable that all but one study included in this section are observational in nature with the majority utilising retrospective data. This comes with inherent biases not already discussed that should be considered when interpreting the results. These include issues with stage migration, lead time bias and recording bias.

Studies that adjusted for stage may have over-estimated the effect of the organisational characteristic through stage migration. (218) It is likely that specialist hospitals have more ready access to onsite diagnostic modalities. Hence patients seen at such centres are more likely to be accurately staged. Therefore, the apparent adjusted improvement in survival rates seen in specialist organisation may be due to accurate staging.

Similarly lead time bias occurs when the period of observation is different for specialist hospitals versus general hospitals. Several of the included studies acknowledge that specialist hospitals are likely to have a more advanced infrastructure leading to timely treatment. Therefore, the differences seen in survival are to do with the hospital infrastructure rather than the characteristic under study e.g. the speciality of the surgeon or teaching status.

Finally, the results of several included studies depend on the accuracy of the data recorded. The quality of the data entry is likely to be better in institutions where there are resources to facilitate data management; this tends to be in specialised hospitals.

*2.4.2.3.4 Study population*

Twenty-four studies (29%) were based on a surgical population. However, in an era of immunotherapy showing promising results in the management of lung cancer, the significance of studying a non-surgical population requires attention. This review captured only one study that explores hospital volume in a non-surgical population and shows a modest survival advantage in HVC (150)

2.4 Summary of specialist care findings

Acknowledging these limitations, the trend suggests that specialist care is likely to be an important determinant of patient outcomes in lung cancer. However, elements of a hospital infrastructure and the relationship between such factors playing a significant role in altering outcomes requires further investigation. These findings also show the importance of equitable access to specialist services, with deprived populations highlighted as facing significant barriers. This inequity is associated with a decreased likelihood of treatment and receipt and poorer survival compared to patients from other socioeconomic backgrounds. Longer travel distances is perceived to be a barrier however, the presented results suggest this does not manifest as an obstacle to treatment receipt.

## 2.4.3 Co-ordination of care

2.4.3.1 What are the main findings?

Care co-ordination is an approach to healthcare that is delivered in a logical, comprehensive and timely manner ensuring all patients' needs are met and there is continuity of care. Co-ordinated care in lung cancer is shown to be vital in achieving improved outcomes. (226) Therefore, several UK guidelines including the 'National Optimal Pathway' and NICE guidelines emphasise the importance of timely care. (86,227) Moreover, qualitative data

collected from providers, patients and carers described delays and lack of co-ordination as a major challenge to accessing high quality cancer care. (228)

This review examines interventions that aim to improve the co-ordination and timeliness of care. These include multidisciplinary care, care co-ordination programmes and rapid diagnostic programmes.

The majority of studies in this section demonstrate an improvement in the timeliness of care through the implementation of the described interventions which is in keeping with the literature. The aim of nurse navigators is to improve the flow of lung cancer care and address barriers to low income individuals to gaining access to cancer care. (229) Navigators share information between the MDT and patient, co-ordinate clinical schedules and provide emotional support. (230) This review shows there is evidence to support the utility of this role which is in keeping with other cancer studies. (231) The impact on timeliness of care and increased treatment rates are unsurprising given the navigators experience with working with patients with lung cancer and the familiarity with the health system setting.

Rapid diagnostic and care co-ordination programmes lead to speedier care by addressing delays through the implementation of simultaneous interventions. This is in keeping with the results of two systematic reviews that found that interventions aimed at improving co-ordination of care decreased wait times, though not all studies reported or found statistical significance. (83,96) Finally, multidisciplinary care aims to improve the quality of cancer management and access to treatment. It has been established as the standard of care in several countries including the UK. However, evidence for the effectiveness of the MDT is lacking. A systematic review published in 2008 failed to demonstrate a beneficial effect on patient outcomes such as treatment rates or survival. (97) This review presents an updated review of

the evidence and reiterates the lack of robust evidence supporting an impact on survival, treatment rates or timeliness of care.

However, though there was a general trend for improved timeliness of care, results of other outcomes such as survival or quality of life were mixed. In addition, limited conclusions can be drawn from these studies due to the following limitations.

2.4.3.2 Limitation with co-ordination of care intervention studies

Three issues to consider when interpreting the evidence are 1.) Study heterogeneity 2.) Study variation and 3.) Adjustment for confounders. Firstly, in each category there is large heterogeneity in the included studies. For example, for those where timeliness of care was the main outcome of interest, the definition in the measures of wait times including start and stop times varied. Similarly, the details of what comprised MDT care were sometimes poorly reported and details of length, number of cases discussed, professionals present and context of the management discussion in the patient pathway were sparse in all the studies.

In addition, there was significant variation in study design and patient population. This variation makes quantitative comparison challenging. On the other hand, the spread of interventions across a variety of countries suggests that a reflective snapshot of tested interventions is provided that captures a large population.

Secondly, there was poor adjustment for confounding factors such as age, stage, tumour subtype and co-morbidities. This may explain why some studies found results showing that speedier care resulted in worse survival rates. In these studies, patients with more advanced disease, require fewer diagnostic investigations and are more likely to receive a prompt radiological diagnosis and best supportive care but die earlier than those with early stage disease.

Finally, due to the number of confounding factors influencing lung cancer outcomes, it is difficult to isolate the intervention as being definitively associated with patient outcomes. Many of the studies were before and after design. In a rapidly developing speciality, it is likely that changing treatment and diagnostic paradigms contributed. In addition, hospital infrastructures are unlikely to remain static. Therefore, in common with other similar reviews caution should be exercised when evaluating organisational interventions as independent factors in a whole pathway. (232)

#### 2.4.3.3 Summary of care co-ordination findings

With the above limitations in mind, the presented results represent a comprehensive synthesis of studied interventions aimed at improving the co-ordination of care and the impact on patients with lung cancer. This summary highlights three main findings. Firstly, it emphasises the need for continued improvement in timeliness of care demonstrated by the variability in reported mean and median wait times. Secondly, a range of successful interventions are described, the delivery of which are dependent on the availability of sufficient staff with appropriate skills. Finally, important research gaps are identified.

### 2.4.4 How does this apply to lung cancer commissioning in the UK?

Data from the NLCA has shown that the care for patients with lung cancer has improved over the last ten years. Surgical resection rates have increased from 13.7% in 2010 to 17.1% in 2017 with one year survival improving from 31% to 37% in the same time period. (214) Despite these improvements, outcomes in the UK still lag behind those in comparable countries. (79)

This review suggests that improvements in patients' outcomes can be achieved through improved access to specialist time and reduced staff workload. Governing bodies, in the UK recognise staffing is a priority, with a plan set out in the "Cancer Workforce Plan". (233) However, this review and national reports identify that as well as increasing number and skills of staff, a change in the way services are accessed nationally is required to deliver equitable standards of modern cancer care. (234)

The UK has a 'hub and spoke' model of delivery of specialist cancer care organised in networks. My results question whether this represents equality in access to lung cancer service provision. (148)(158)(162)(90). Despite the acknowledged limitation of the evidence, large centres with specialists that have dedicated time to deliver lung cancer care are shown to achieve better treatment and survival rates. Specialised hospital infrastructures with dedicated on-site facilities are likely to contribute to such a success. It has, therefore been proposed that a centralised approach to services may minimise the variation in care and outcomes in the UK. (235) This might enable the adequate recruitment and retention of specialist staff, timely access to key diagnostic and treatment modalities, co-ordinated multidisciplinary care and access to research studies and clinical trials.

However, a survey conducted in 2013 of hospital physicians in the UK with an interest in lung cancer reported that three quarters of participants did not feel that lung cancer should be managed in fewer centres. (91) There are six main arguments in favour of this viewpoint. Firstly, it can be argued that the holistic care of this multi-comorbid group is better placed in a general hospital. With the majority of lung cancer cases presenting at an advanced stage and two thirds of patients being diagnosed over the age of 70, therefore ready access to other specialities such as a diabetes or cardiology is vital. (214) Secondly, centralising lung cancer services may lead to the de skilling of local hospital staff who will still manage cancer

patients in an emergency setting. This is particularly relevant in lung cancer where over 40% of lung cancer cases are diagnosed as part of an emergency. (20) Thirdly, local centres have the potential to model the same standard of care provided in specialist centres. This review provides some evidence that service delivery through local hospitals fosters collaboration and networking. The use of technology (e.g. video conferencing) can maximise regular team working in a time efficient manner. Fourthly, each cancer network, on average, sees approximately 2,500 new cases per year. Given this volume, there is currently insufficient capacity for all lung cancer patients to be seen in specialist centres. Fifthly, it should be noted that the majority of studies advocating for a move to large volume specialist centres are based on American studies, hence the results may not be directly transferable to a UK setting where distances may be smaller. An individuals' private insurance status and affordability to access care is shown to be a major factor in predicting outcome with some studies demonstrating a greater effect than hospital volume or specialist status (153) and again this would be less applicable to UK care. Finally, despite, the existence of a public health system in the UK that is free on the point of receipt, significant variation in access to optimal care is reported. This review emphasises that more deprived patients are less likely to receive treatment or have access to specialist care and the site of care studies highlight that level of deprivation is the main driver of outcome. Therefore, there is an argument that services should be redesigned to remove barriers to accessing specialist lung cancer care rather than potentially increasing barriers through the regionalisation of services.

In summary, there are advantages and disadvantages to both models of service delivery. What is clear is that to improve outcomes for patients with lung cancer, services must ensure that patients can access the same high-quality specialised care. The provision of adequate

dedicated time for specialised staff to care for patients is key to achieving this. Whether this is done in a local hospital or a specialised centre is still up for debate.

### 2.4.5 Strengths and limitations of the review

As far as I am aware this is the first systematic review that synthesises the evidence investigating organisational interventions directly linked to patient outcomes. The unique use of a scoping review of the general medical literature and broad search criteria enhanced capture of articles and provides a robust overview of the subject. Additionally, a systematic approach to article selection, review methods and formal quality assessment provides clarity on the methodological quality of the included articles allowing meaningful interpretation of the observed results to a UK setting.

However, in addition, to the limitations acknowledged in the section 2.4.2.3 and 2.4.3.2, three main areas of weakness are recognised. Firstly, the challenges of conducting a comprehensive search of health systems literature have been described in section 2.1.3 and described in previous reviews. Three approaches were used to address this. 1.) A scoping review was conducted to ascertain important subject areas to include in the final search strategy. 2.) Three databases were searched using a deliberately broad search strategy. 3.) Experts in literature searching were consulted to optimise the search strategy 4.) Field experts identified further relevant articles. These techniques resulted in the inclusion of a variety of articles studying a range of interventions in several settings. However, it is acknowledged that relevant articles may have been missed.

Secondly, many included studies scored high in the risk of bias assessment. Several of these biases have already been discussed but two further biases pertain to the entire review:

confounding and publication bias. The influence of confounding is shown in Figure 2.8. Difficulty in isolating organisational interventions from other influencing factors represented a challenge in the majority of studies. Additionally, there is likely to be a number of unrecognised confounding factors at play such as patient preference. For example, studies investigating the impact of teaching hospitals may not be able to account for patients that elect to seek care from non-teaching hospitals if they want less aggressive treatment. Details of decision making are not captured by clinical or administrative datasets and are out of the scope of this review.

Another bias is the influence of publication bias. Studies that report a positive result are more likely to be published that those that report negative or no significant findings. This has been acknowledged as a significant factor to consider in organisational reviews. (99) Several studies implementing organisational change are likely to occur at a local level and therefore less likely to be published in full article format. Consultation with experts in the field of lung cancer ensured that results and conclusions presented in this review are in keeping with general consensus.

### 2.4.6 Gaps in the literature

A key aim of this review was to identify gaps in the literature and areas for future research. The paucity of robust studies on the subject is demonstrated by the fact that only four randomised controlled trials were identified. Prospective, good quality studies are required to gain a better understanding of how organisational interventions impact patients with lung cancer; in part this led to my studies reported in Chapter 3.

The review highlights that the interplay of organisational factors in impacting lung cancer outcomes is under investigated. The discussion sections of several of the included studies

recognise that it is likely that a group of organisational factors influence patient outcomes. However, which factors drive the association is not well understood. In Meguid et al's study investigating the impact of hospital teaching status on outcomes demonstrated that a high-volume status was the driving factor associated with improved outcomes. (157) Additionally, when controlled for surgeon speciality in a post hoc analysis, the significant association found with improved survival was lost. Similar findings have been shown by other studies at different cancer sites. Dimick et al also showed that the association with hospital teaching status and mortality was due to increased hospital volumes for patients with pancreatic, hepatic and oesophageal cancers. (236) The ability of a hospital system to function effectively and efficiently is influenced by several organisational factors other than case mix. Moreover, these factors are likely to be inter-dependent. However, few studies examine the individual influence of such characteristics in univariate and multivariate analyses with other organisational factors. This is key to identifying key organisational components that are vital for a high-quality lung cancer service.

## 2.5 Conclusions

Review of the lung cancer literature highlight that the co-ordinated access to specialist care is likely to be an important determinant of patient outcome. The results present some evidence for improved survival, treatment rates and quality of life associated with specialist centres. However, strong conclusions cannot be drawn from the available evidence due to the heterogeneity and methodological quality of the included studies. There are pros and cons to a move to specialist centres in the UK but access to specialist services remains a key theme. If this is best achieved through the provision of care in specialist treatment centres or with a hub and spoke model is up for debate. What is clear, is that several gaps in the literature exist meriting further investigation. A greater understanding of the influence of the interplay of organisational factors on patient outcomes would enable models of lung cancer service delivery to be commissioned that are evidenced to improve care for lung cancer patients.

# CHAPTER 3 THE SECOND NATIONAL LUNG CANCER ORGANISATIONAL AUDIT: RESULTS AND IMPACT OF ORGANISATION AND SPECIALIST SERVICE DELIVERY ON LUNG CANCER OUTCOMES

## 3.1 Introduction

Lung cancer outcomes within the UK show significant unwarranted variation. (85) Chapter 2 demonstrates that organisational factors contribute to this variation but the interplay of these factors on lung cancer outcomes is poorly understood.

This chapter assesses the current state of UK lung cancer service provision and investigates the relationship between resource provision and lung cancer outcomes using an organisational score.

### 3.1.1 The commissioning of lung cancer services

Making diagnoses earlier and faster is central to the National Cancer Programme. (234) To achieve this a timed lung cancer diagnostic pathway has been implemented. This pathway emphasises the importance of ruling out cancer within 28 days so that those with cancer receive treatment earlier. This 'Faster Diagnosis Standard' is to be fully introduced in April 2020.

The 'National Optimal Lung Cancer Pathway' sets out how lung cancer services can be organised to achieve this target. (86) It aims to improve treatment times, increase the

proportion of patients treated with curative intent through better performance status and reduce variation in clinical practice. Key features include the following: 1.) CXR to CT and clinic in less than 24 hours 2.) Rapid turnaround times for testing and reporting 3.) Daily respiratory clinic opportunities 4.) Curative intent management pathway. A document entitled 'Clinical Advice to cancer alliances for the commissioning of the whole lung cancer pathway' provides recommendations to commissioners and lung cancer 'Expert Advisory Groups' on the investments required to implement change. (11)

3.1.1.2 The provision of lung cancer services in UK

The National Lung Cancer Organisational Audit in 2014 provided the first snap shot of service provision in England and Wales. (85) The article highlighted significant variation in the availability and workload of lung cancer specialists, diagnostic and treatment services. The audit show that some trusts had no access to essential resources such as video assisted thoracoscopy (VAT) lobectomy and stereotactic radiotherapy. To address national gaps in service provision the following recommendations were made:

1. Maximum of 30 patients discussed per MDT meeting.
2. Diagnostic and non-cancer cases discussed at a separate MDT meeting.
3. Lung CNS's workload should not exceed 80 new cases per whole time equivalent per year.
4. All lung cancer MDTs should have access to all diagnostic tests and prompt thoracic radiology and pathology input.
5. All treatment modalities, including VAT lobectomy and stereotactic radiotherapy, should be available to all patients.

6. All trusts should participate in the next round of the national lung cancer organisational audit.

The authors additionally performed a multivariate logistic regression analysis to assess the feasibility of linking service provision to patient outcome. They demonstrate an association between higher surgical resection rates and on-site availability of advanced staging modalities such as PET scan and VAT lobectomy. These findings add weight to the hypothesis that there is an association between resource factors and lung cancer outcomes. However, this relationship needs further detailed exploration to understand how services can be optimally organised.

### 3.1.2 The need for a second national organisational lung cancer audit

Lung cancer is the third most common diagnosed cancer in England but accounts for the most deaths(3). Section 1.7.1 shows that UK has low cancer survival when compared with other European countries. (237) In addition, national variation in one-year survival is demonstrated with five-year survival figures ranging from 12.4% to 17.6% across cancer alliances. (238)

The first organisational audit reflected this variation. (85) However, three years on, little is known about the current provision of lung cancer services. Understanding national gaps in access to services is vital if improvements in outcomes are to be made.

Chapter 2 demonstrated that ready access to key diagnostic and treatment facilities is key to achieving improved outcomes. This was shown to be more likely to be achieved by specialist centres that have facilities on site. Therefore, this chapter explores the national availability of key diagnostic and treatment facilities in the UK. The following modalities allow optimal lung cancer management: EBUS, local anaesthetic thoracoscopy, video assisted thoracoscopy,

PET CT, cardiopulmonary exercise testing, EGFR/ALK/PD-L1 testing, biological therapy, immunotherapy, stereotactic radiotherapy, thoracic surgery, VAT lobectomy, pulmonary rehabilitation and smoking cessation service. The significance of these facilities are described in section 1.5

In addition to establishing national access to resources, an understanding of how the organisation of services directly impact patients is required if outcomes are to be improved. It is hypothesised that the recommendations proposed by the commissioning guidance will lead to better patient care. However, there is a paucity of evidence available to underpin such recommendations. The systematic review in the previous chapter outlines some service factors shown to improve outcomes. However, there is lack of knowledge of how these components individually and as a combination contribute to the optimal model. Exploring the relationship between organisational factors and patient outcomes individually and combined in an organisational score will be critical in defining factors evidenced to improve lung cancer outcomes. This will guide policy about the minimum resources required for a hospital to deliver a safe and effective lung cancer service.

### 3.1.3 Organisational scores

The creation of an organisational score based on the metrics recommended in the commissioning guidance aims to investigate the hypothesis that implementation of the National Optimal Pathway will lead to improved patient outcomes.

Few scores assessing organisational aspects of care are commonly used in healthcare despite the increasing body evidence suggesting that resource factors significantly contribute to patient outcomes. (85) The majority of scores that do exist combine clinical measures to

predict a particular health outcome to guide clinical decision making. (239) For example, the CURB 65 score predicts mortality for patients that present to hospital with community acquired pneumonia. (240) A low score can prompt outpatient oral antibiotic treatment whilst a higher score correlates with a higher risk of mortality and hence requires more aggressive monitoring and treatment.

Organisational scores in use mostly originate in the USA. (239) They are created by private healthcare providers to gain an overview of cost effectiveness of a hospital. Consequently, such scores have limited applicability to a UK service structure.

A literature search for organisational scores used in a UK population revealed one study described in section 2.1.5.2. (108) Price et al explored the relationship between the resources available for the care of COPD patients and patient outcomes. Patient level data was derived from forty consecutive patient notes and organisational components collected from a survey. The score comprised of fourteen organisational components thought to represent good clinical practice. The authors show that units with the worse scores had proportionately more patients staying longer in hospital. No significant associations were found with mortality or readmission rates. However, Price et al show that mortality was lower in units with more respiratory staff per 100 beds and suggests that units with four or more respiratory physicians per 1000 beds have better mortality rates. This trend was not replicated with increased general physician numbers at a senior or junior level. The authors conclude that the availability of more respiratory physicians in a unit is proxy for a resource rich environment. They advocate that this whole systems approach affects patients care rather than any individual component. Their score did not include staffing components, but the article acknowledges the importance of addressing this deficiency in future scores. As mentioned in section 2.4.2.2.1, factors that

describe a well organised stroke unit have been set out and a similar process needs to occur for cancer care. (220)

There are two main advantages in creating a composite organisational score for lung cancer services. Firstly, an overview of the processes within an organisation facilitates benchmarking. High performing organisations can be identified and studied to understand process that can be applied to low performing units. Additionally, policy makers can target extra resources to trusts where inequity has been demonstrated.

Secondly health care providers of low scoring institutions are equipped with robust evidence to present to local service commissioners when lobbying for adequate resource provision. A single number is more easily understandable then several individual measures to monitor change within an organisation. (241)

### 3.1.4 Aims and objectives

The aim of this chapter is to study the national variation of lung cancer services and study the impact of specialist service delivery on lung cancer outcomes.

The specific objectives are:

1. What proportion of people with lung cancer have on site availability of key diagnostic tests: EBUS, local anaesthetic thoracoscopy, video assisted thoracoscopy, PET CT, cardiopulmonary exercise testing, EGFR mutation testing /ALK/PD-L1 testing?

2. What proportion of people with lung cancer have on site availability to the following treatment modalities: biological therapy, immunotherapy, stereotactic radiotherapy, thoracic surgery, VAT lobectomy, pulmonary rehabilitation and smoking cessation service?

3. What are the individual organisational factors that influence time to treatment, one-year survival and curative intent treatment rate?

4. What is the association between a bundle of organisational factors with time to treatment, one-year survival and curative intent treatment rate?

## 3.2 Methods

### 3.2.1 The second ‘National lung cancer audit’ (NLCA) organisational audit

An electronic survey was sent to all lung cancer leads (156) in England and Wales in June 2017. The survey included questions on workforce provision, diagnostic procedures and treatment modalities. The questions were based on the 2014 survey but modified following feedback from three pilot testing sites and the NLCA clinical team. Table 3.1 shows the survey questions and definition of items included.

The NLCA team consist of a project manager, project co-ordinator, four clinical leads and the author (clinical research fellow). This team works in collaboration with several key stakeholders. The University of Nottingham provides analysis of the collected data(4). Clinical leadership is provided by lung cancer experts recruited through the Care Quality Improvement Department of the Royal College of Physicians. (4) Finally, the NLCA executive group is constituted by the Society for Cardiothoracic Surgery (SCTS), the Roy Castle Lung Cancer Foundation (representing lung cancer patients), Wales Cancer Network Lung Cancer Group, the National Lung Cancer Forum for Nurses and the British Thoracic Oncology Group. (4)

Participants were required to undergo a registration process prior to completing the survey. This was to ensure up to date contact details were available for all respondents. The survey opened on the 5$^{th}$ of June 2017 with a close date of 30$^{th}$ June 2017. A ‘helpdesk’ was provided via email and telephone to provide trusts support with completion of the survey and ensure

consistency of results. The ‘Help notes’ provided to trusts are shown in Table 3.1. Weekly reminders were sent via email to trusts that had not completed the survey.

Once the responses were collated, a process of data cleaning was undertaken. In view of the wide variability in the reporting of staffing provision, emails seeking data verification were sent to trust reporting a figure of >2. The replies were collected on 4th August 2017. The final responses were tabulated in an Excel spreadsheet.

An evaluation of the process of the organisational audit was conducted in March 2018. Feedback sources were as follows:

1.) Evaluation forms were sent to the NLCA user group. This is a group of lung cancer specialists that have volunteered to provide feedback to the work of the NLCA.
2.) Additional free text comments included at the end of the survey
3.) Email and telephone communication from participants.
4.) NLCA team feedback

**Table 3.1 Survey questions and definitions**

| Question No | Data Item | Data Definition |
|---|---|---|
| 1 | Please enter the name of your Trust/Health board | **Hospital**: An organisation providing secondary healthcare services in England/Wales. A hospital trust may be made up of one or several hospitals within a region.<br><br>**If you are in England**: we will be asking about services that relate to your specific trust<br>**If you are in Wales**: we will be asking about services that relate to your specific hospital |
| 2 | Please enter your trust/health board code | |
| 3 | Please provide us with the following details about the **lung cancer lead** | **Lung cancer lead**: The professional in your hospital taking overall responsibility for the services provided to lung cancer patients.<br><br>This person will have overall responsibility with the audit department for the data quality from your hospital. This person will 'sign off' the responses to this audit. |
| 4 | Do you have separate diagnostic and treatment MDT meetings? | **MDT**: 'multidisciplinary team'-a group of healthcare professionals working in a coordinated manner for patient care.<br><br>**Diagnostic MDT Meeting**: Meeting where the patients' diagnostic work up is planned. Non-cancer cases may be discussed at this meeting. Typically attended by an MDT co-ordinator, chest physician and thoracic radiologist.<br><br>**Treatment MDT Meeting**: Meeting where the patients' management is discussed. Only patients with a suspicion of lung cancer are discussed at this meeting. Must have the following core members in attendance throughout the meeting: MDT co-ordinator, lung cancer physician, thoracic radiologist, thoracic pathologist, lung cancer clinical nurse specialist, lung cancer medical oncologist (chemotherapy), lung cancer clinical oncologist (radiotherapy) and a thoracic surgeon. |
| 5 | How often are your full MDT meetings? | Full MDT= Treatment MDT |

| | | |
|---|---|---|
| 6 | On average, how many patients are discussed at your full MDT meeting/s per week? | The number reflects the average number of cases per week discussed at a full MDT in June 2017.<br>If more than one full MDT per week- the average number of patients discussed in a week during these meetings is required. |
| 7 | What is the time allocated for your full MDT meeting/s? | Time that is allocated for all core members to be in attendance at the meeting.<br>If there is more than one MDT per week the total time allocated in a week is required. |
| 8 | Please provide us with the following information relating to staff who are involved in the management of lung cancer patients at your Trust. It is very important that accurate information is submitted, therefore please verify the number (of whole-time equivalents) with the appropriate departments.<br><br>(a) Lung cancer clinical nurse specialist<br>(b) Lung cancer physician<br>(c) Lung cancer medical oncologist (chemotherapy)<br>(d) Lung cancer clinical oncologist (radiotherapy)<br>(e) Thoracic surgeon<br>(f) Thoracic radiologist<br>(g) Research Nurse | **Whole time equivalent (WTE)**: An WTE of 1.0 means that the person is equivalent to a full- time worker, while an WTE of 0.5 signals that the worker is half- time or half of their full-time work is dedicated to lung cancer/thoracic work.<br>For example, a medical oncologist may work full time but has 3 sessions dedicated to lung cancer per week. Assuming a 10-session week-the number quoted should be 0.3.<br><br>**Lung cancer clinical nurse specialist**:<br>A nurse specialising in the care of people diagnosed with lung cancer (and mesothelioma).<br><br>**Lung cancer physician**: A consultant physician with specialist skills in diagnosing and managing lung cancer (>50% of their job plan should be dedicated to lung cancer work which may include clinics, bronchoscopies, MDT's and administration time)<br><br>**Lung cancer medical oncologist**: Oncologist with specialist skills in providing chemotherapy to lung cancer patients.<br><br>**Lung cancer clinical oncologist**: Oncologist with specialist skills in providing radiotherapy and chemotherapy to lung cancer patients.<br><br>**Thoracic surgeon**: A consultant thoracic surgeon who has performed at least one lung cancer resection in the last 12 months.<br><br>**Thoracic radiologist:** A consultant radiologist with specialist skills in thoracic imaging.<br><br>**Research nurse**: A registered nurse who is involved with the delivery of lung cancer clinical |

| | | |
|---|---|---|
| | | trials and studies. |
| 9 | Please provide the following information relating to diagnostic and staging modalities available to your lung cancer patients.<br><br>a. EBUS<br>b. Local anaesthetic thoracoscopy<br>c. Video assisted thoracoscopy<br>d. PET<br>e. Cardiopulmonary exercise testing<br>f. EGFR mutation testing<br>g. ALK mutation testing<br>PDL1 testing | **On site**: This service is provided for your lung cancer patients at your trust/healthboard.<br><br>**Off site**: Access to this service is provided for your lung cancer patients via an established referral pathway to another trust/healthboard.<br><br>**Not available**: There is not a provision for access to this service for your lung cancer patients at your trust/healthboard or via an established referral pathway. |
| 10 | Please provide us with the following information relating to treatment modalities available to your lung cancer patients.<br><br>a. Biological therapy e.g. TKIs<br>b. Immunotherapy e.g. PDL1 inhibitor<br>c. Stereotacic radiotherapy<br>d. Thoracic surgery<br>e. VAT lobectomy<br>f. Pulmonary rehabilitation<br>g. Smoking cessation | **Biological therapy:** Therapies targeting specific cell mutations. E.g. Tyrosine kinase inhibitors.<br><br>**Stereotactic radiotherapy:** External radiation that precisely delivers a high irradiation dose to a target.<br><br>**VAT lobectomy (Video assisted thoracoscopy) lobectomy:** Removal of a lobe of the lung via a VAT procedure.<br><br>**Immunotherapy**: treatment inhibiting PDL1 pathway |
| **FOR TRUSTS PROVIDING THORACIC SURGERY ON SITE** | | |
| 11 | How many WTE thoracic surgeons do you have? | **Whole time equivalent (WTE)**: An WTE of 1.0 means that the person is equivalent to a full- time worker, while an WTE of 0.5 signals that the worker is half- time or half of their full-time work is dedicated to thoracic work.<br><br>**Thoracic surgeon**: A consultant thoracic surgeon who has performed at least one lung cancer resection in the last 12 months. |
| 12 | How many thoracic surgery theatre sessions are there per week? | |
| 13 | How many thoracic high dependency beds do you have? | |

| | | |
|---|---|---|
| | | **Surgical theatre session**: A scheduled period of operating theatre time allocated to a consultant thoracic surgeon. 1 session is half a day.<br><br>**Thoracic high dependency bed**: A level 2 bed staffed with a minimum of one nurse to two patients. The bed is specifically allocated to cardiothoracic patients. |
| 14 | Please use this space to provide any additional comments you may have. | |

### 3.2.2 Development of the organisational score

An organisational score for lung cancer services was produced by adding one point for eleven organisational factors. Studies have reported that a significant limitation of composite scores is that components are based on information that is easily gathered or available. (239) To address this, a score was created on pre-determined objectives as outlined in the 'Lung Cancer National Commissioning Guidance'. Table 3.2 shows the items included in the organisational score. The total score was split into three groups for analysis.

**Table 3.2 Items included in the organisational score**

| **Access to the following**: | **Score** |
|---|---|
| One whole time equivalent (WTE) respiratory physician direct clinical care per 200 new diagnoses per year | 1 |
| Radiologist with at least a third of their job plan devoted to lung cancer | 1 |
| Medical oncologist with at least a third of their job plan devoted to lung cancer | 1 |
| Clinical oncologist with at least a third of their job plan devoted to lung cancer | 1 |
| One WTE LCNS per 80 new diagnoses per year | 1 |
| Separate diagnostic planning multi-disciplinary team (MDT) meetings from treatment MDT meetings | 1 |
| Onsite PET scan | 1 |
| Onsite Endobronchial Ultrasound (EBUS) | 1 |
| Onsite Thoracoscopy | 1 |
| Access to molecular testing (EGFR and ALK) | 1 |
| Cardiopulmonary exercise testing (CPEX) | 1 |
| | |
| **Total score** | **11** |

### 3.2.3 Patient level data collection

The organisational results were linked to trust level patient outcomes for trust first seen using the NLCA dataset for England and Wales. This is a validated database established in 2005, which consists of anonymised records of individuals with a diagnosis of lung cancer.

The patient population includes all individuals receiving a diagnosis of lung cancer which may include histological diagnosis or clinical diagnosis. At the time of the survey the most recently available data from the NLCA included patients diagnosed up to 31st December 2015 (updated for survival till 01/10/2016). Patients were included if they had a diagnosis of lung cancer (ICD code C34).

NHS hospitals in England submit details for all lung cancer patients including patients undergoing lung cancer surgery via the Cancer Outcomes and Services Dataset (COSD) to the NLCA via the National Cancer Registration and Analysis Service (NCRAS) at Public Health England. COSD is a generic cancer registry dataset that includes additional clinical and pathological site-specific data items relevant to different tumour types. The data for Wales are collated and quality assured by the Wales Cancer Network (WCN). The NLCA dataset is linked to the following: Hospital Episode Statistics (HES), the National Radiotherapy Dataset (RTDS), the Systemic Anti-Cancer Dataset (SACT) and Office of National Statistics Data. A pseudo-anonymised extract is then submitted to the NLCA analysis team.

Case ascertainment is measured by the audit annually to ensure that cases are not selected to be submitted by trusts. Case ascertainment rates are measured by comparing the number of cases submitted each year with the expected numbers based on historic data from other cancer registries. In England, the use of processed cancer registration data linked to the above data

sources means that a case ascertainment of approximately 100% is achieved for all trusts. (242)

Unique to other routinely collected worldwide datasets, the NLCA collects detailed clinical data. (242) This allows accurate risk adjustment analyses to be conducted. Data completeness for the 2015 patient cohort was high. 76% of patients had performance status recorded, 95% had stage recorded and 53% of patients with good performance status and early stage disease had FEV1% recorded and 55% had FEV1 recorded.

Patients are allocated to hospitals trusts on a "trust first seen basis" which is recorded as a data item routinely collected. This avoids duplication where patients may have been first seen at one trust but received treatment elsewhere. In 18% of trusts in England this field was blank or contained two contradictory values. (242) In these cases, an algorithm is used to assign trust first seen on the basis of other data in the database. Patients are assigned to peripheral centres over tertiary centres and site of diagnostic testing over site of treatment receipt.

### 3.2.4 Patient level data cleaning

Start and end dates were created for survival analyses. The date of diagnosis was used as the start date. In the absence of a date of diagnosis the following were used as an alternative in the following order:

1.) Date of first histological or cytological confirmation of this malignancy (except for histology or cytology at autopsy). The date is in the following order:
    a.) Date when the specimen was taken
    b.) Date of receipt by the pathologist

c.) Date of the pathology report

2.) Date of admission to hospital because of this malignancy

3.) When evaluated at an outpatient clinic only: - date of first consultation at the out-patient clinic because of this malignancy.

4.) Date of diagnosis other than above

An end date was generated using the date of death (obtained from the Office for Statistics database) or the date that data cleaning commenced which was the 01/10/2016.

### 3.2.5 Covariates

The following variables were identified from the NLCA data: sex, age at diagnosis, socioeconomic status (derived from the postcode and linked with the Index of Multiple Deprivation), Eastern Co-operative Oncology Group (ECOG) performance status (according to the WHO definition) and stage of disease at presentation TNM version 7 (as classified by 'The IASLC Lung Cancer Staging Project'). (18) The HES database was used to calculate the Charlson Co-morbidity Index (a composite score that has been validated for use in this dataset) preceding the date of lung cancer diagnosis. (158) These co-variates were chosen as they are established as affecting patient outcome in lung cancer and have been used in previous studies using the NLCA dataset. (158) In particular, the importance of socioeconomic status is highlighted in section 2.4.2.2.3. Variable definitions are described in Table 3.3.

**Table 3.3 Variable definitions**

| Variable | Source | Comment/Definition |
|---|---|---|
| Sex | NLCA | Recorded as male or female |
| Age | NLCA | Age at diagnosis |
| Performance status | NLCA | Eastern Co-operative Oncology Group (ECOG) performance status according to WHO definition:- 0: fully active, able to carry on all pre disease performance without restriction; 1: restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature e.g. light house work, office work; 2: Ambulatory and capable of all selfcare but unable to carry out any work activities. Up and about more than 50% of waking hours; 3: capable of only limited selfcare, confined to bed or chair more than 50% of waking hours; 4: completely disabled. Cannot carry on selfcare. Totally confined to bed or chair; 5: dead. |
| Stage | NLCA | Stage of disease at presentation as classified by TNM version 7 (as classified by 'The IASLC Lung Cancer Staging Project'). |
| Socio-economic status using the Townsend Score for Deprivation | NLCA derived | This measure is derived from a patients' postcode which is linked with the Townsend score for deprivation. This is divided into quintiles with 1 being the most affluent quintile and 5 representing the least. |
| Co-morbidity status using the Charlson Co-morbidity Index | HES derived | The HES dataset contains up to twenty diagnoses for each hospital episode coded using ICD-10. This data will be used to calculate the Charlson Index, which is a composite score of co-morbidity which has been validated in cohorts of men and women with both malignant and non-malignant diseases. ICD-10 codes for lung cancer were excluded for the calculation. |
| Received surgery | NLCA/HES | All patients with a valid date recorded of a curative surgical procedure Surgical operation were identified with the Office of Populations Census and Surveys Classification of Interventions and Procedures version 4 (OPCS-4) codes for each patient indicating thoracic surgical procedure with curative intent. The surgical procedures were categorised as 1) pneumonectomy, 2) lobectomy, including sleeve and bilobectomy, 3) sub-lobar resections, comprising segment and wedges, 4) complex resection and others |

| | | |
|---|---|---|
| Received radiotherapy | NLCA/RTDS | All patients with a valid date recorded for the receipt of radiotherapy. |
| Received chemotherapy | NLCA/SACT | All patients with a valid date recorded for the receipt of lung chemotherapy. |
| Received best supportive care | NLCA derived | All patients that did not receive active treatment (see below for definition of active treatment). |
| Date of diagnosis | NLCA derived | The date of diagnosis is a derived field from the following order of declining priority:<br>1.) Date of first histological or cytological confirmation of this malignancy (except for histology or cytology at autopsy). The date is in the following order a.) date when the specimen was taken, or b). date of receipt by the pathologist or c). date of the pathology report.<br>2.) Date of admission to hospital because of this malignancy<br>3.) When evaluated at an outpatient clinic only: date of first consultation at the out-patient clinic because of this malignancy.<br>4.) Date of diagnosis other than the above. |
| Date of death | NLCA/Office for Statistics | As per Office for Statistics database |
| Received curative intent radiotherapy | Derived | All patients with non-small cell lung cancer (NSCLC) with a valid date of radiotherapy with a dose of >50Gy. |
| Received curative intent treatment | Derived | All patients with NSCLC that received surgery or curative intent radiotherapy. |
| Time to first treatment | Derived | Date of first treatment (chemotherapy, radiotherapy or surgery) minus date of diagnosis in days |
| Received treatment within 62 days | Derived | All patients where the time to treatment is ≤62 days |
| Survival | Derived | Date of death-Date of diagnosis or 01/10/2016 in days |
| One-year survival | NLCA derived | All patients with survival ≥12 months |

### 3.2.6 Outcomes

Three outcomes were measured. The first was curative-intent treatment rate, which was defined as the proportion of patients with non-small cell lung cancer (NSCLC) with a record of a curative surgical procedure or patients who received radiotherapy with curative intent (>50Gy). The second was receipt of active treatment within 62 days. Active treatment was defined as the proportion of patients who had a valid treatment start date for surgery, chemotherapy or radiotherapy. The third was the proportion of patients alive at one year. The studied outcomes relate to treatment rates as treatment is critical to improving overall patient outcomes. The rationale for the chosen outcome variables are summarised in Table 3.4.

**Table 3.4 Rationale for outcome variables**

| **Outcome** | **Rationale for assessment** |
|---|---|
| One-year survival | The biggest chance of survival is receiving appropriate treatment.<br>To test the hypothesis that having access to specialist staff and resources correlates is associated with better survival. |
| Receipt of active treatment within 62 days | Faster pathways are evidenced to improve patient outcomes. National cancer standards mandate that cancer treatment should be provided within 62 days from referral. NLCA does not record referrals dates so the date of diagnosis was used as a proxy. To test the hypothesis that access to specialist resources is associated with an increased chance of receiving treatment within 62 days. |
| Curative intent treatment | To test the hypothesis that patients with access to resources are more likely to receive radical intent treatment. Patients that receive curative intent treatment have a better chance of improved survival. |

### 3.2.7 Statistical Analysis

All data and statistical management were performed by STATA V.14 (StataCorp). Multi-variate logistic regression analysis was used to estimate the odds of receiving curative intent

treatment, treatment within 62 days and one-year survival by the organisational score adjusting for patient and organisational factors. A mixed model effects model was chosen to account for the hierarchical nature of the data. This method recognises that organisational features are measured at a trust level whilst patient features are measured at an individual patient level. To minimise bias resulting from reverse causation, only patient factors known at the time of diagnosis were considered in the final multi-variate model. The organisational score data was categorised into three groups. A p value of $<0.05$ was considered statistically significant.

### 3.2.8 Power

The dataset provided by the National Lung Cancer Audit is one of largest and most complete cancer datasets worldwide. (4) Therefore, there is statistical power associated with the analyses even when assessing subgroups of patients.

### 3.2.9 Ethical considerations

The author is a member of the NLCA team; therefore an amendment was granted on the data sharing agreement between the Office of Data Release and the University of Nottingham NLCA research team as an additional processor. This allows access to audit data at the University of Nottingham site, for the purposes of analysis of the organisational audit only. Additionally, ethical approval was gained for access to patient level data (IRAS number: 237237).

# 3.3 Results

## 3.3.1 Results of the second organisational audit

One hundred and thirty-eight responses to the organisational audit survey were submitted from 156 trusts (88% participation rate; 85% for England; 92% for Wales). After removal of duplicate and empty records 129 records (83%) were available for analysis, which compares to 57% participation rate in 2014.

### 3.3.1.1 Comparison of 2014 organisational audit results to 2017

Table 3.5 shows the number of hospitals that met the recommendations made in the first organisational audit in 2014 compared to 2017. The number of units with a separate diagnostic MDT meeting has increased from 29% to 43%, however one third of providers still discuss more than 30 patients per MDT meeting list.

**Table 3.5 Number (%) that met the recommendations made in the first organisational audit in 2014 compared to 2017**

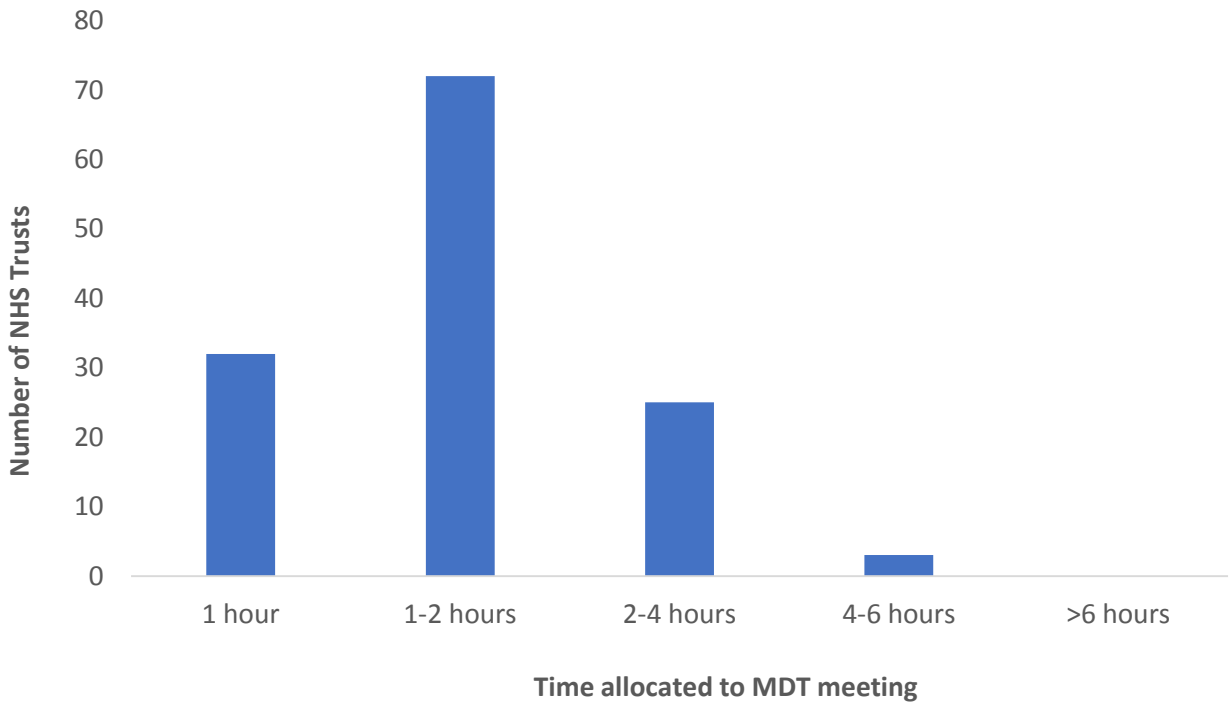
| **Recommendation** | **2014 n (%)** | **2017 n (%)** |
|---|---|---|
| Maximum of 30 patients discussed per MDT meeting | 75 (74) | 91 (69) |
| Diagnostic and non-cancer cases discussed at a separate MDT meeting | 29 (29) | 57 (43) |
| Lung CNSs workload should not exceed 80 new cases per whole time equivalent per year | 16 (20) | 24 (18) |
| All lung MDTs should have access to all diagnostic tests | 79 (85) | 99 (77) |
| All treatment modalities should be available to all patients | 84 (90) | 116 (90) |
| All trusts should participate in the national lung cancer organisational audit | 101 (57) | 132 (83) |

LCNS: Lung cancer specialist nurse

3.3.1.2 Multidisciplinary team meeting

The first organisational audit recommended that trusts should have separate diagnostic and treatment MDT meetings. The diagnostic MDT meeting is where the patients' diagnostic work up is planned. Non-cancer cases may be discussed at this meeting as well. The treatment MDT meeting is where patients with a suspicion of lung cancer management is discussed. 44% (n=58) of trusts have a separate diagnostic and treatment MDT meeting. The majority of treatment MDT's occur weekly (94%, n=124). There is variation in the amount of time allocated by MDT's for this meeting illustrated in Figure 3.1. The majority (55%) of trusts allocate 1-2 hours with 24% allocating just one hour.

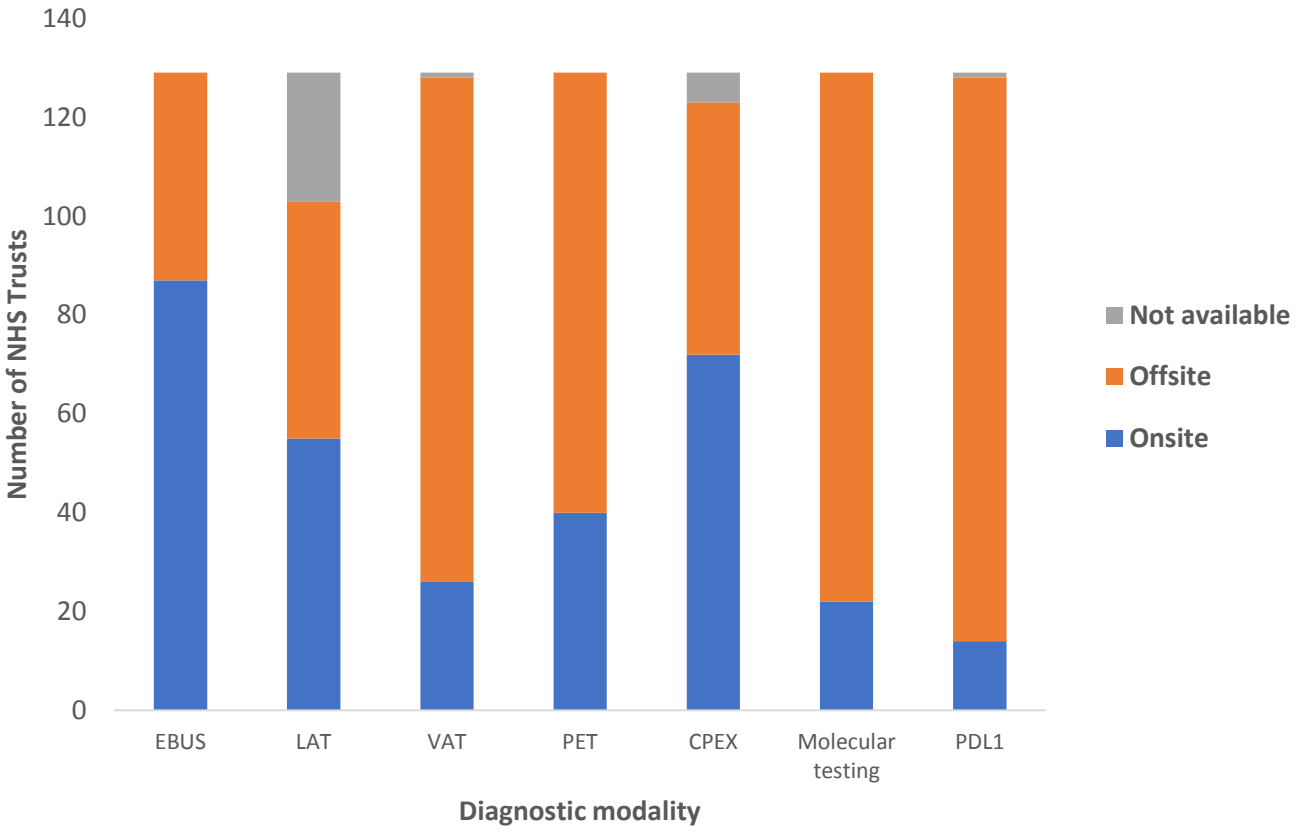
**Figure 3.1 Time allocated for discussion of patients by NHS trusts in the main MDT meeting**



3.3.1.3 Diagnostic/staging services

Figure 3.2 illustrates the spread of access to diagnostic facilities. There is variation in availability of diagnostic facilities at NHS trusts. All trusts have access (on or off site) to EBUS, PET scan and molecular testing (ALK and EGFR) facilities. The provision of onsite EBUS has increased from 44% to 67% in three years. All but one trust has access to PDL-1 testing. 123 trusts (95%) have on or off-site access to cardiopulmonary exercise (CPEX) testing, with 6 trusts (5%) having no access to this testing modality. Finally, local anaesthetic thoracoscopy is unavailable in 20% of trusts (14% in 2014).

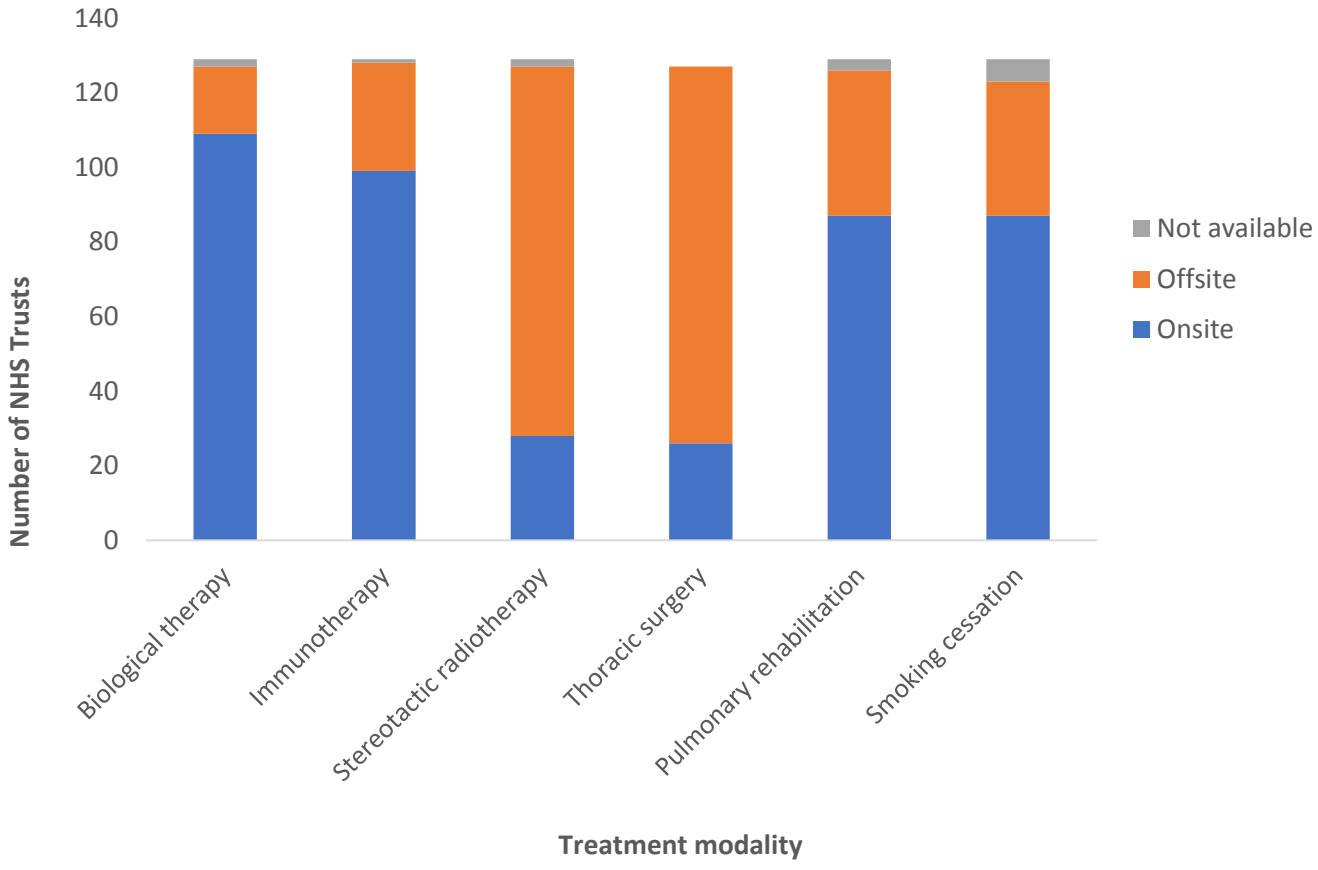
**Figure 3.2 National access to diagnostic modalities for lung cancer**



3.3.1.4 Lung cancer treatments

The national provision of lung cancer treatments in summarised in Figure 3.3. All trusts have on or off-site access to thoracic surgical services. All but one trust has access (on or off site) to immunotherapy. Very few trusts had no access to biological therapy (2%) and stereotactic radiotherapy (SABR) (2%). Provision of onsite pulmonary rehabilitation (81% to 67%) and smoking cessation services (86% to 67%) has decreased over three years.

**Figure 3.3 National access to treatment modalities for lung cancer**



3.3.1.5 Staffing

The mean (range) number and workload of lung cancer specialists available to each trust is shown in Table 3.6. There is national variation in workforce provision. The number of annual lung cancer diagnoses seen per whole time equivalent (WTE) of time dedicated to lung cancer work for thoracic surgeons ranges from 0 to 4520 with a median of one surgeon per 256 new lung cancer patients per year. The role with the least variability is lung cancer clinical nurse specialists (LCNS). Units have a median of two WTE nurses (range 0.2-5). The median workload varied from one LCNS per 9 to 479 new patients per year with a median of 106. Only 18% of units met the 2014 recommendation that LCNS's workload should not exceed 80 new cases per WTE per year.

**Table 3.6 The median (range) number and workload of lung cancer specialists available to each unit**

| | Number of whole-time equivalents (WTE) | Workload |
|---|---|---|
| Lung cancer clinical nurse specialist | 2 (0.2-5) | 106 (9-479) |
| Lung cancer physician | 1.47 (0-8) | 136 (0-2009) |
| Lung cancer medical oncologist (chemotherapy) | 0.5 (0-4) | 189 (0-4110) |
| Lung cancer clinical oncologist (radiotherapy) | 1 (0-5.2) | 316 (0-4520) |
| Thoracic surgeon | 1 (0-4.5) | 256 (0-4520) |
| Thoracic radiologist | 1 (0-5) | 187 (0-1910) |
| Research Nurse | 0.2 (0-4.3) | 125 (0-4060) |

PA's: Programmed Activities: four hours work within a normal working week; Workload is expressed as annual lung cancer diagnoses per WTE specialist allocated to lung cancer work.

### 3.3.2 Organisational score

The overall organisational score varied by hospital trust from zero to eleven. Thirty-eight (29%) units had a score of 0-4, 64 (50%) units had a score of 5-7 and 27 (21%) units had a score of 8-11. Table 3.7 shows the number of lung cancer units that met each of the individual recommendations included in the score. There was a wide range of compliance with the recommendations, from only 24 (18%) units meeting the recommendation of one whole time equivalent lung cancer nurse specialist per 80 new diagnoses per year, to 107 (83%) units reporting a radiologist with a third of their job plan devoted to lung cancer.

**Table 3.7 Number of hospitals that met the recommendations included in the organisational score from the second organisational audit (n=129)**

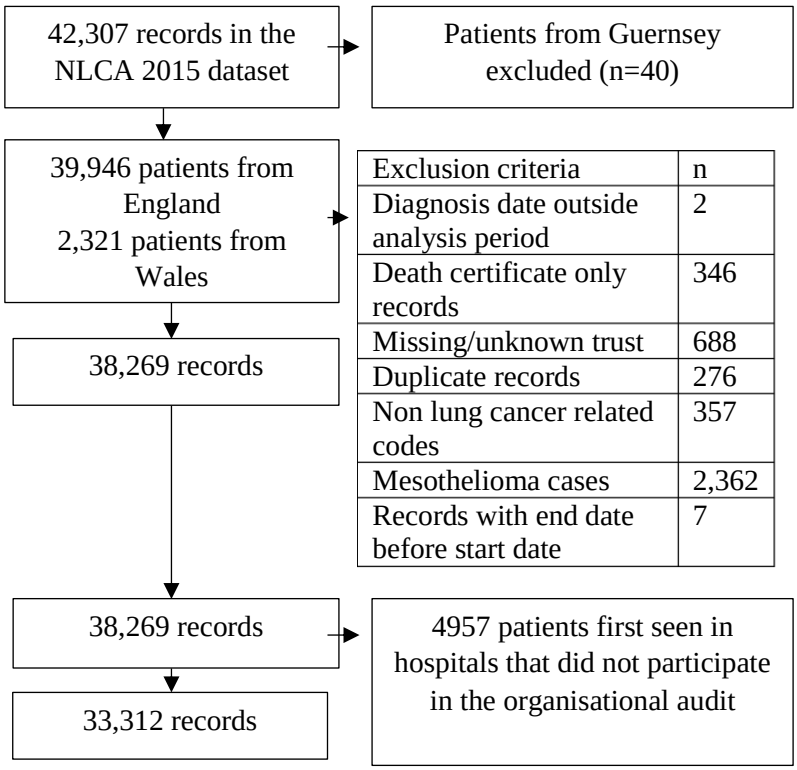
| | Number | % |
|---|---|---|
| One whole time equivalent respiratory physician direct clinical care per 200 new diagnoses per year | 79 | 61 |
| Radiologist with at least a third of their job plan devoted to lung cancer | 107 | 83 |
| Medical oncologist with at least a third of their job plan devoted to lung cancer | 77 | 60 |
| Clinical oncologist with at least a third of their job plan devoted to lung cancer | 90 | 70 |
| One whole time equivalent LCNS per 80 new diagnoses per year | 24 | 19 |
| Separate diagnostic planning multi-disciplinary team meetings | 57 | 44 |
| Onsite PET scan | 40 | 31 |
| Onsite Endobronchial Ultrasound | 87 | 67 |
| Onsite Thoracoscopy | 68 | 53 |
| Onsite access to molecular testing | 25 | 19 |
| Onsite cardiopulmonary exercise testing | 72 | 55 |

LCNS: Lung clinical nurse specialist, PET: positron emission tomography

### 3.3.3 Patient level results

The NLCA identified 42,307 patients who were diagnosed with lung cancer between 1 January 2015 and 31st December 2015. The cohort criteria are illustrated in Figure 3.4. A total of 33,312 patients were included in the final analysis. The patient demographic details for the study cohort are shown in Table 3.8. Fifty-three per cent (n=17,797) were men and 55% (n=18, 165) were aged between 65- 80 years old. 7433 patients (25.0%) received treatment with curative intent, 16773 (50.4%) patients received treatment with 62 days of diagnosis and 11547 (34.7%) patients were alive at one year from diagnosis.

**Figure 3.4 Cohort flow diagram**




| Exclusion criteria | n |
|---|---|
| Diagnosis date outside analysis period | 2 |
| Death certificate only records | 346 |
| Missing/unknown trust | 688 |
| Duplicate records | 276 |
| Non lung cancer related codes | 357 |
| Mesothelioma cases | 2,362 |
| Records with end date before start date | 7 |

**Table 3.8: Patient demographics**

| | | Patients (n) | % |
|---|---|---|---|
| Sex | Female | 15,516 | 46.6 |
| | Male | 17,796 | 53.4 |
| Age | <65years | 7,329 | 22.0 |
| | 65-80 years | 18,165 | 54.5 |
| | >80 years | 7,818 | 23.5 |
| Stage | IA | 3,359 | 10.1 |
| | IB | 2,233 | 6.7 |
| | IIA | 1,269 | 3.81 |
| | IIB | 1,178 | 3.54 |
| | IIIA | 3,812 | 11.4 |
| | IIIB | 3,019 | 9.06 |
| | IV | 16,778 | 50.3 |
| | Missing | 1,664 | 5.0 |
| Performance status | 0 | 4,816 | 14.5 |
| | 1 | 8,681 | 26.1 |
| | 2 | 5,373 | 16.1 |
| | 3 | 4,877 | 14.6 |
| | 4 | 1,613 | 4.8 |
| | Missing | 7,952 | 23.9 |
| Townsend quintile | 1 (most affluent) | 4,534 | 13.6 |
| | 2 | 5,968 | 17.9 |
| | 3 | 6,787 | 20.4 |
| | 4 | 7,520 | 22.6 |
| | 5 (least affluent) | 8,431 | 25.3 |
| | Missing | 72 | 0.2 |
| Charlson index | 0 | 10,715 | 32.2 |
| | 1 | 5,405 | 16.2 |
| | 2 | 5,397 | 16.2 |
| | 3+ | 11,795 | 35.4 |

### 3.3.4 Linkage of the organisational audit with NLCA patient results

The results of the multivariate logistic regression analyses of patient factors and organisational score on patient outcomes are shown in Table 3.9. The results demonstrate that, compared to organisational score of 0-4, patients seen at hospitals with a score of 8-11 had a higher one-year survival (adjusted OR (95% CI)= 2.30 (1.04-5.08), p<0.001), higher curative-

intent treatment rate (adjusted OR (95% CI) = 1.62 (1.26-2.09), p<0.001) and greater likelihood of receiving treatment within 62 days (adjusted OR (95% CI) = 1.49 (1.20-1.86), p<0.001).

The provision of onsite diagnostic/treatment modalities (onsite provision of EBUS, PET, EGFR, ALK mutation testing, PDL-1 testing, smoking cessation services, pulmonary rehabilitation, stereotactic radiotherapy, surgery, biologics, immunotherapy) individually were not significantly associated with the studied patient outcomes (when adjusted for patient and organisational factors and clustered for trust). Full results of the proportions, unadjusted and adjusted odd ratios of patient of organisational and staffing factors by patient outcome (likelihood of curative-intent treatment, all treatment within 62 days and one-year survival) are shown in the appendix (A4)

.

**Table 3.9 Results of multivariate logistic regression analyses using a mixed effects model investigating the influence of patient factors and organisational score on studied outcomes**

| | | One-year survival | | Treatment within 62 days | | Curative intent treatment | |
|---|---|---|---|---|---|---|---|
| | | Adjusted OR (95% CI) | p value for chi squared | Adjusted OR (95%CI) | p value for chi squared | Adjusted OR (95%CI) | p value for chi squared |
| Sex | Female | 1.00 | | 1.00 | | 1.00 | |
| | Male | 0.71 (0.70-0.75) | <0.001 | 0.97 (0.93-1.03) | 0.378 | 0.91 (0.84-0.98) | 0.016 |
| Age | <65years | 1.00 | | 1.00 | | 1.00 | |
| | 65-80 | 0.76 (0.71-0.82) | | 0.60 (0.56-0.64) | | 0.77 (0.70-0.85) | |
| | >80 years | 0.45 (0.41-0.50) | <0.001 | 0.18 (0.16-0.19) | <0.001 | 0.22 (0.19-0.25) | <0.001 |
| Stage | IA | 1.00 | | 1.00 | | 1.00 | |
| | IB | 0.65 (0.56-0.76) | | 1.03 (0.91-1.17) | | 0.96 (0.83-1.10) | |
| | IIA | 0.41 (0.35-0.49) | | 1.05 (0.91-1.23) | | 0.69 (0.58-0.82) | |
| | IIB | 0.31 (0.26-0.36) | | 1.02 (0.87-1.19) | | 0.50 (0.43-0.60) | |
| | IIIA | 0.17 (0.15-0.20) | | 1.10 (0.98-1.22) | | 0.19 (0.17 (0.21) | |
| | IIIB | 0.08 (0.07-0.10) | | 1.42 (1.26-1.60) | | 0.04 (0.33-0.05) | |
| | IV | 0.04 (0.03-0.04) | <0.001 | 0.84 (0.77-0.92) | <0.001 | 0.01 (0.01-0.01) | <0.001 |
| Performance status | 0 | 1.00 | | 1.00 | | 1.00 | |
| | 1 | 0.60 (0.55-0.66) | | 0.66 (0.60-0.72) | | 0.54 (0.48-0.60) | |
| | 2 | 0.30 (0.27-0.34) | | 0.31 (0.28-0.34) | | 0.20 (0.17-0.22) | |
| | 3 | 0.12 (0.10-0.13) | | 0.09 (0.08-0.10) | | 0.03 (0.03-0.04) | |
| | 4 | 0.05 (0.04-0.06) | <0.001 | 0.03 (0.03-0.04) | <0.001 | 0.09 (0.00-0.02) | <0.001 |
| Townsend quintile | 1 (most | 1.00 | | 1.00 | | 1.00 | |
| | 2 | 0.87 (0.79-0.97) | | 0.91 (0.83-0.99) | | 1.02 (0.88-1.17) | |
| | 3 | 0.94 (0.85-1.05) | | 0.85 (0.77-0.93) | | 0.93 (0.81-1.07) | |
| | 4 | 0.88 (0.80-0.98) | | 0.82 (0.75-0.90) | | 0.96 (0.84-1.12) | |
| | 5 (least | 0.82 (0.74-0.90) | 0.060 | 0.75 (0.68-0.82) | <0.001 | 0.87 (0.75-1.00) | 0.614 |
| Charlson Index | 0 | 1.00 | | 1.00 | | 1.00 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 0.94 (0.86-1.02) | | 1.28 (1.18-1.39) | | 1.15 (1.40-1.73) | |
| | 2 | 0.85 (0.77-0.92) | | 1.10 (1.02-1.20) | | 1.32 (1.18-1.50) | |
| | 3+ | 0.62 (0.58-0.67) | <0.001 | 1.14 (1.07-1.22) | <0.001 | 1.07 (0.96-1.20) | <0.001 |
| Organisational | 0-4 | 1.00 | | 1.00 | | 1.00 | |
| | 5-7 | 1.89 (0.99-3.61) | | 1.14 (0.95-1.37) | | 1.13 (0.92-1.40) | |
| | 8-11 | 2.30 (1.04-5.08) | <0.001 | 1.49 (1.20-1.86) | <0.001 | 1.62 (1.26-2.09) | <0.001 |

## 3.4 Discussion

These data provide an important overview of lung cancer services in England and Wales. We show that there remains significant variation in the provision of services, specifically diagnostic and treatment modalities, and provision of staff across the UK. The results go further to demonstrate that the provision of resources and organisation of care is associated with patient outcomes through the novel use of an organisational score.

### 3.4.1 Organisational audit findings

#### 3.4.1.1 Access to onsite diagnostic/treatment modalities

It is reassuring that most diagnostic and treatment modalities are available on or off site. The results for the provision of these facilities are discussed further below.

EBUS facilities provided on site has increased by 23% over the last three years. The importance of ready access to EBUS been demonstrated by Navani et al in a randomised controlled trial comparing lung cancer diagnosis and staging with EBUS transbronchial needle aspiration with conventional approaches. (88) They showed that the use of EBUS as the initial investigation after staging CT results in a faster treatment decision, fewer investigations and improved survival. Therefore, improving access to the third of trusts that currently do not have onsite access to EBUS has the potential to optimise the management of lung cancer patients.

All units reported access to a PET scan however, this was off site for two thirds. Over the last decade it is increasingly recognised that access to PET scanning is essential for the modern management of lung cancer. (227) The NICE guidelines for the diagnosis and management of lung cancer recommended that all patients potentially suitable for curative intent treatment are offered a PET-CT and every cancer network should have a system of rapid access to this facility. (227). This is underpinned by randomised controlled trial evidence showing that compared with conventional staging, PET scanning reduces the frequency of thoracotomy without cure (243,244). It is therefore a concern that seven units specifically commented on the slow speed of access to PET scanning at their organisation in the free text portion of the survey.

A key part of the future of lung cancer management is access to targeted treatment. Molecular diagnostic tests assess the genetic make-up of a patients' cancer to identify whether that individual is eligible for targeted medicine. (245) Access to these tests are fundamental to ensure that all management options are explored. Among patients with a mutation in the EGFR gene, 80-90% show evidence of response to targeted treated compared to only 20-40% responding well to standard chemotherapy. (245) Whilst all trusts have access to molecular testing, the majority (approximately 80%) reported off site testing which is likely to impact on speed of testing to inform clinical decision making. These results are in keeping with finding published by CRUK on the provision of molecular diagnostics in England. (245) This report estimates a gap of 13,825 tests in 2014 by subtracting the provision of tests (22,097) from the demand (35,922). A contributing factor to this gap in provision may be timely access to testing.

Trials investigating immunotherapy agents (a form of targeted therapy) have shown improved overall survival and progression free survival compared to standard chemotherapy treatment

alone (72,246). Therefore, improving the access to these drugs through on-site availability and provision of adequate oncology specialists is vital. The survey shows that the over three quarters of units have on site access to immunotherapeutic agents and 70% of trusts have a clinical oncologist with at least one third of their job plan devoted to lung cancer. The continued provision of these resources will be increasingly important with new agents being appraised by NICE.

The reduction in provision of essential smoking cessation and pulmonary rehabilitation services is a major concern. The importance of smoking cessation services in the prevention and management of lung cancer is discussed in section 1.4.1. In addition it is emphasised in lung cancer management guidelines. (11,86,227) In addition, two recent publications demonstrate the need to prioritise such services. (247,248) Firstly, a report by the Tobacco Advisory Group of the Royal College of Physicians (RCP) published in 2018 state that "health service commissioners and practitioners have a responsibility to ensure that cost effective smoking interventions are provided and properly implemented. Failure to identify and treat smokers is no less negligent than failure to identify and treat patients with cancer". (247) Secondly, Gemine et al add to the existing evidence that quitting smoking after a diagnosis of lung cancer improves survival. They report a 25% reduction in mortality in those that stopped smoking within three months of diagnosis compared to those who continued smoking. (248)

Despite the growing evidence base highlighting the need to invest in smoking cessation services, local budgets for stop smoking services have been consistently cut for the last four years; which may be reflected in the organisational audit results. (247) In 2016, 59% of local authorities made budget cuts to such services, and 50% in 2017. (247) Total spending in England on stop smoking services in 2013/2014 amounted to approximately 128.1 million,

falling to just 89 million in 2017/18. (247) It is clear that if optimal outcomes for lung cancer are to be achieved, then investment in smoking cessation facilities must be prioritised as advocated by the RCP report.

Studies have shown that pulmonary rehabilitation (PR) has successfully improved outcomes for patients with lung cancer. (249) In a pre or post-operative setting, PR leads to fewer surgical complications. (249) Additionally, improved quality of life has been demonstrated with PR in a non-surgical setting after patients have received chemotherapy or radiotherapy. (250,251) However, compared to the wealth of evidence supporting PR in other respiratory diseases such as chronic obstructive pulmonary disease (COPD), good quality prospective studies are still lacking for lung cancer. (249) Details regarding the optimal duration and time of initiation are lacking. Nevertheless, studies estimate the prevalence of COPD in lung cancer patients varies from 8% to as high as 50% (252,253), where PR is an established management strategy. (254) Improved access to this treatment is therefore integral to the multidisciplinary and holistic management of lung cancer patients.

Finally, only one fifth of trusts have access to onsite thoracic surgery. Previous interrogation of the NLCA demonstrated that the odds of a surgical resection are increased by 37% for patients first seen in a centre where surgeons are on site compared to non-surgical centres. (159) Therefore, strategies to improve access to such facilities must be considered to improve the chance of cure for lung cancer patients.

#### 3.4.1.2 Multidisciplinary care and staffing provision

Multidisciplinary team meetings play a pivotal role in quality decision-making for lung cancer patients. The first organisational audit recommended that trusts should have two MDT meetings. (85) There has been a 20% increase in the number of trusts that now have two

meetings, however the average time spent per patient discussion remains the same (approximately 4-8 minutes/patient). Results from the first organisational audit and lung cancer commissioning guidance recommend a maximum number of 30 patients discussed per MDT meetings to ensure there is adequate time for to discuss treatment options for all patients. (11,85) Analysis of the free text section of the survey revealed strategies that have been implemented to enable a unit to adhere to this recommendation which may have contributed to the improvement in this metric. These included the creation of a dedicated nodule meeting and a triage system reducing the number of patients discussed at MDT. In addition, there are currently several pilot NHS projects evaluating the impact of streamlining MDT meetings which may develop further strategies to achieve this recommendation.

The inequity in staff workload has previously been highlighted as a key issue. (85) This data shows that variability still exists, with only 18% (decreased from 20% in 2014) of trusts meeting the recommendation that there should be one WTE LCNS per 80 new lung cancer diagnoses per year. In a study examining LCNS working practices in the UK, Stewart et al show that increased LCNS workload directly impact patients. (151). They found that LCNS's with a caseload of >250 patients/year were approximately one third less likely to have surgery compared to patients assessed by an LCNS with a workload of ≤150 patients/year. Additionally, data from the NLCA show that patients seen by a LCNS are twice as likely to active treatment (60% vs 30%) than patients that are not(255).

The importance of improving access to specialist lung cancer staff, including LCNSs, is emphasised in section 2.3.4. In addition, a briefing by Cancer Research UK published in November 2018 highlighted this need. (256). They estimate that staff numbers would need to double in 2027 to meet the needs of the population. The report states that even without delivering lung cancer screening, it is likely that 70% more radiologists will be needed in ten

years compared to current levels. If screening is implemented, then hundreds more would be needed on top of this. Government policies have placed workforce requirements central to NHS England's ten-year plan (256); a need reflected in the results of this audit.

### 3.4.2 Organisational score

A novel organisational score was developed to assess the relationship between the organisation of a lung cancer service and the outcomes for patients who are seen at that service. Chapter two demonstrates that the interplay of several organisational factors is likely to achieve better patient outcomes, rather than an isolated factor. In addition, studies suggest that organisational scores are likely to be a reliable way of comparing units. (108,257,258) However, there are few validated scores that examine organisational factors within a healthcare unit.

The created organisational score used in this study is a composite score based on the recommendations made by the national commissioning guidance for lung cancer. (11) These guidelines are primarily based on clinical opinion and relatively little has been published on how these standards affect patient care. This data provide evidence that adherence to this guidance directly impacts patient outcomes discussed further below.

### 3.4.3 Linkage results

To the authors knowledge this is the first study to demonstrate that a bundle of organisational factors is significantly associated with improved lung cancer patient outcomes (one-year survival, receiving curative-intent treatment and treatment within 62 days). Previous studies demonstrate improved treatment outcomes for individual organisational components. For

example, Lau et al demonstrated that increasing the number of thoracic surgeons was associated with increased resection rates. (160). Additionally, previous interrogation of the NLCA dataset demonstrated increased odds of having surgery if a patient is first seen in a surgical centre. (158,159) However robust evidence linking resource factors with survival is lacking.

These results demonstrate that examining organisational factors individually do not robustly contribute to improve outcomes in keeping with findings from the systematic review. However, significant results are found when factors are combined to form a score. The odds of surviving to one year for patients seen at a unit with a high organisational score are more than double than those seen at a low scoring unit after adjusting for patient factors. These findings are unsurprising given that lung cancer patients are often multi-morbid, requiring multiple investigations and combinations of treatment. (4) The challenge for lung cancer services in the UK is to deliver rapid access for all patients to these treatment modalities whilst ensuring that each treatment centre treats sufficient volume of patients to maintain performance and cost-effectiveness.

Finally, it has been demonstrated that speedier lung cancer pathways are associated with better patient outcomes and several guidelines establish standards for the timely care for patients. (96) National UK targets stipulate that patients should receive treatment within 62 days. (227) This study examines the outcome of patients receiving treatment within 62 days and finds that the odds of receiving timely treatment are increased by approximately 50% if seen in a high scoring unit (compared to a low scoring unit). It is intuitive that ready access to key resources within an increasingly complex patient pathway would relate to a faster pathway and the results confirm that this is the case.

### 3.4.4 Clinical relevance and recommendations

I show that national variation in provision of services and workforce exist despite the publication of several initiatives to address this inequality. We provide evidence that adherence to the National Commissioning Guidance for lung cancer has the potential to improve patient outcomes within the current service structure.

Four specific recommendations are made to address the national variation in lung cancer services shown in Box 1 and published in the latest NLCA report. (4)

**Box 1: Key recommendations from the second organisational audit**

1.) Local access to smoking cessation and pulmonary rehabilitation should be available to all patients
2.) Dedicated time for all core MDT members to attend a weekly MDT meeting discussing no more than 30 patients in 2 hours.
3.) Provision of specialist time commitment as specified in the National Commissioning Guidance, in particular lung clinical nurse specialists.
4.) All providers without a separate diagnostic MDT should implement this within the next 12 months as per commissioning guidance.

### 3.4.5 Strengths and limitations

.

The main strength of the study is the completeness and quality of the NLCA dataset. This now includes the linked RTDS and SACT dataset which allows accurate assessment of treatment rates and provides a detailed picture of lung cancer treatment and management in England. In addition, participation in the organisational audit was high, with the quality of responses enhanced by the provision of help notes and a help desk.

Four main limitations are acknowledged. Firstly, the results are retrospective and may be subject to confounding and selection bias despite adjustment for patient factors. However, a range of trust size and geographical spread across the country were included in the audit.

In terms of confounding there are likely to be organisational elements that are not able to be accounted for such as details of the quality of the services investigated. In the free text portion of the survey, one trust reported that they had on site PET facilities, however, the demand on that service is high. Therefore, patients wait seven to fourteen days to have their scan and get results back. On the other hand, another trust reports off site PET CT scanning resources but a good relationship with the provider allowing for a quick turnaround on results. Other confounders to consider is the inability of datasets to account for patient preferences or ability to access services. However, the high participation rate and findings in keeping with previous work means that these effects of bias are likely to be minimal and therefore the results are likely to be generalisable to the UK population.

Secondly, data submitted to NCRAS making up the NLCA dataset is inputted during the MDT meeting. Therefore, NLCA data reflects the MDT decision rather than the final treatment received. It is acknowledged that there may be potential issues with competing risks where patients may die before they have started the documented treatment modality. This is common to all large nationally collected datasets. In addition, accurate UK data on MDT decision implementation rates is not available. However, patient factors known to determine eligibility for treatment and survival are included in multivariate analysis.

Additionally, it should be noted that the survey results are not externally validated and may be subject to recall bias. This is particularly relevant to the reporting of staffing numbers. To gain accurate data, the second organisational audit required participants to respond with a greater

level of detail compared to the first. Evaluation of this audit revealed that respondents found estimating specialist workload overly complex. To address this, trusts had the opportunity to verify their data with further guidance provided. However, issues in accuracy may remain and difficulty with defining staff workload has been acknowledged by previous researchers. (259)

Lastly, data regarding service provision was collected in 2017 and was linked to patient data from 2015 This is the most recently available patient data at the time of the organisational audit results, as there is a fourteen-month lag from a patient being seen to their data being reported to the NLCA. However, the linkage results are likely to be valid for two reasons. Firstly, services are unlikely to have changed significantly in twelve months. Secondly, the NLCA results for key performance indicators have remained largely static for the last five years.

## 3.5 Conclusions

Inequity to access to key resources nationally exists contributing to variability in lung cancer outcomes. This study provides robust evidence that improvements in survival and timeliness of care can be achieved through national adherence to the lung cancer commissioning guidance. For this to be a reality further investment in specialist lung cancer services is key. Lung cancer still receives the least funding of all common tumours yet has the lowest survival rates. (91) These findings strengthen the case that urgent ring-fenced funding is required if patient outcomes are to be improved to be in line with comparable countries.

# CHAPTER 4 MANAGEMENT OF STAGE III NSCLC IN ENGLAND

## 4.1 Introduction

Stage III non-small cell lung cancer (NSCLC) as defined by the International Association for the study of Lung Cancer 8th Edition TNM staging classification is a heterogenous disease. (18) The extent can vary from small volume, potentially curable locoregional disease to bulky invasive multinodal disease.

Approximately 20% of patients in the UK present with Stage III NSCLC (12% at Stage IIIA and 8% at Stage IIIB) which has an estimated five-year survival of approximately 20%. (4) The optimum treatment, based on randomised trials and meta-analyses, for unresectable disease is concurrent chemoradiation. (260) However, a study investigating treatment patterns in patients with Stage III NSCLC reported the most common treatment delivered to 2365 patients from British Columbia, Canada, was radiotherapy alone; given to just over a half of all actively treated. (261) In an Australian population studied, the authors found the commonest treatment given to approximately one third of patients was also radiotherapy alone. (262) Whereas, data from the USA showed that multimodality treatment regimens with chemotherapy/radiotherapy or surgery in combination with either chemotherapy or radiotherapy were more commonly used than in the Australian or Canadian studies. (263) This corresponds to a five year survival figure quoted in US population studies of 33%. (264)

Differences in management are reflected in international variation in survival outcomes. The overall age standardised one-year net survival for stage III NSCLC studied in four countries with comparable incomes (Denmark, Canada, UK and Sweden) varied from 30% in the UK to

46% in Sweden. (80) In addition to international differences, stage specific variability in survival outcomes have been shown within regions of the UK. (4,148)

Three factors may contribute to this observed variation in practice and outcomes: 1.) The lack of consensus on optimal treatment regimens 2.) Variability in access to diagnostic and treatment resources 3.) Applicability of trial evidence to real life

### 4.1.1 Management of Stage III NSCLC

The treatment of stage III NSCLC represents a challenge because of variability in presentation. Randomised trial evidence has established the standard of care for unresectable stage III NSCLC being concurrent chemoradiotherapy. (260) However, the management of potentially resectable Stage IIIa(N2) disease remains controversial with data to support both surgical and non-surgical approaches.

A multimodality approach to treatment is considered optimal with locally advanced disease being controlled with systemic treatment (chemotherapy) and local disease treated with either radiotherapy or surgery. (265) Over the last decade, trials have investigated the optimal bimodality or tri-modality treatment for patients with N2 disease. A metanalysis published in 2015 suggested there was no difference in overall survival between patients treated with surgery with chemotherapy or chemotherapy and radiotherapy. (266) The most recent randomised controlled trials that have studied tri-modality treatment are the ESPATUE trial by Eberhardt et al and The Swiss Group for Clinical Cancer Research (SAKK) trial, both published in 2015. (267,268) In the ESPATUE trial patients were all given induction chemoradiotherapy and then randomised to either surgical resection or completion of definitive chemoradiation. (267) They found no overall five- year survival difference between the two groups. In the SAKK trial, all patients had induction chemotherapy and then either

surgery alone or radiotherapy followed by surgery between 2002 and 2012. (268) Again, there was no significant difference in their primary endpoint which was progression free survival but there was a higher radiological response, mediastinal downstaging, complete resection and complete pathological response rates in the tri-modality group.

In summary, the evidence suggests that no one bimodality/tri-modality treatment regimen has superiority in terms of overall survival for stage IIIA (N2) disease. However, there is some evidence to support induction treatment with chemotherapy in terms of complete pathological response rates and downstaging.

The uncertainty in the optimal regiment from trial evidence is reflected in differences between international guidelines on the management of this subgroup (summarised in Table 4.1). In addition, differences in eligibility for surgery are seen.

**Table 4.1 Summary guideline recommendations on the management of potentially resectable N2 NSCLC**

| Guideline | Definition of eligibility for surgery | Recommendations |
|---|---|---|
| BTS & SCTS (2010) | Non-fixed and non-bulky lymph nodes<br>Single zone N2 disease with a reasonable chance of complete resection and clear pathological margins. | If the definition for surgery fulfilled: consider surgery as part of multimodality treatment.<br>Adjuvant chemotherapy in preference to preoperative chemotherapy. |
| ACCP (2013) | Discrete lymph nodes which are easily measures and defined. Disease is free from major structures. | Definitive chemoradiotherapy or induction therapy (chemotherapy or chemoradiotherapy) followed by surgery.<br>Surgery followed by adjuvant chemotherapy not recommended. |
| ESMO (2015) | Minimal, non-bulky, single station N2 disease. | Definitive chemoradiotherapy, induction therapy (chemotherapy or chemoradiotherapy) followed by surgery. |
| NCCN (2018) | Lymph nodes that are low volume, non-invasive, <3cm and pathologically proven. | Definitive chemoradiotherapy, induction therapy (chemotherapy or chemoradiotherapy) followed by surgery.<br>Maintenance Durvalumab following chemoradiotherapy |
| NICE (2019) | Does not define eligibility | Definitive chemoradiotherapy followed by surgery |

BTS: British Thoracic Society; SCTS: Society for Cardiothoracic Surgery; ACCP: American College of Chest Physicians; ESMO: European Society for Medical Oncology; NCCN: National Comprehensive Cancer Network**; NICE: National Institute of Clinical Excellence**

### 4.1.2 Organisation of lung cancer services and stage III NSCLC

The ability of patients to access specialist care is key in this subgroup of patients who require accurate staging and multimodality treatments. This is emphasised in the ESMO guidelines that recommend that stage III patients should be managed in experienced multi-disciplinary teams in high volume treatment centres. (269)

The accuracy of mediastinal staging is integral to this care. This is dependent on ready access to modern diagnostic modalities. Positron emission tomography (PET) CT should be used to rule out distant metastases and initiate mediastinal staging. However, PET scans have a false positive rate of 25% for N2 disease. (269–271) Consequently, PET positive findings should be pathologically confirmed to inform appropriate treatment strategies. (269) One study showed that half of patients with clinical stage IIIa (N2) disease treated surgically were subsequently shown to have been staged incorrectly. (272) The majority of patients being down staged to stage I or II. Therefore, to ensure patients are given the best chance of cure, accurate staging dependent on availability of key diagnostics is necessary.

Curative intent strategies require expertise from staff and access to treatment modalities. (269) Thoracic surgery for stage III disease may involve complex operations including sleeve resections, and resection of locally invaded mediastinal organs. (269) Additionally, access to specialist radiation oncology services is required to evaluate the toxicities and efficacies of the treatment as well as specify volumes and doses that minimise risk to other organs. Expert staff are key to the delivery of these services and specialist care has been associated with greater access to curative treatment and significantly better survival. (262)

Section 3.3 demonstrates that access to such resources varies across the country and this has been shown to affect patient outcomes. Therefore, understanding the relationship between the

availability of specialist services and lung cancer outcomes in this important subgroup, will facilitate policy design to bring up survival to the highest international standard.

### 4.1.3 Applicability of trial evidence

It is evident that controversy exists as to the optimal management of Stage IIIA NSCLC. However, the generalisability of clinical trial evidence to patients discussed in the lung cancer multidisciplinary team (MDT) meeting should be questioned for three main reasons.

Firstly, most of the investigating clinical trials encountered significant problems with recruiting enough numbers of patients to meet their pre-defined power calculations, leading to insufficient power. In addition, the time taken to recruit patients meant that the diagnostic and management modalities used during the trial were outdated by publication of the results. For example, most randomised controlled trials were carried out before the routine use of PET scans. Secondly, most patients with this stage of disease are elderly with multiple co-morbidities, a group that is under-represented in clinical trials(273). De Ruysscher et al estimate that half of stage III patients do not fulfil the criteria from randomised controlled trials evaluating chemoradiation therapy. (274) The median age of diagnosis of lung cancer is 72 years old, yet these trials included few patients over the age of 70. (260,269) These factors result in limited high-level evidence to base treatment for many patients. Finally, patient experience outcomes are poorly reported in such trials. When there are largely equivalent survival outcomes associated with the different management approaches, patients experience data is critical in decision making.

With the above factors in mind, it is likely that the feasibility of conducting further clinical trials in this area are limited. However, the interrogation of detailed prospective population data sets has the potential to add significant value to the current literature base.

### 4.1.4 Rationale

Population based data registries can fill the knowledge gap between clinical trial data and clinical practice. The above factors highlight the importance of using such data to understand variability in practice and outcomes, target quality improvement initiatives and guide national resource allocation. An example of how this process has been successfully implemented is illustrated in the EUROCARE studies. Data was used to assess outcomes resulting in changes on healthcare funding and structure. (275)

To my knowledge, the establishment of current national patterns of treatment and corresponding survival outcomes in stage III NSCLC patients in the UK has not been previously established. Utilising the National Lung Cancer Audit (NLCA) database to achieve this presents a unique opportunity for three reasons. Firstly, the NLCA dataset is one of the most complete cancer datasets available worldwide. (95) The data has been historically used to make improvements in quality key performance indicators. (4) Secondly, the availability of details of treatments received by patients including drug names, doses, frequency and timing, through linked datasets allows accurate allocation of treatment regimens; a deficiency highlighted in other population based studied investigating Stage III patients. Finally, understanding treatment patterns of stage III NSCLC patients is topical given the recently updated National Institute of Clinical Excellence (NICE) lung cancer guidance (March 2019) newly recommending tri-modality treatment for stage IIIA (N2) disease as well as the new NICE technology appraisal for use of adjuvant Durvalumab after concurrent chemoradiation. (42)

### 4.1.5 Aims

The aims of this study are to:

1.) Investigate the uptake of difference treatment regimens and the corresponding survival outcomes for Stage III NSCLC in England

2.) Examine the association with hospital infrastructure and access to key treatment and diagnostic modalities with the likelihood of receiving curative intent treatment and one-year survival in patients with Stage III NSCLC in UK

## 4.2 Methods

### 4.2.1 Data source and study population

The NLCA dataset and data collection process has previously been described in section 3.2. The following patients are excluded from the data: patients identified with lung cancer through death certificate only, patients with non-lung cancer related pathology codes and patients who cannot be assigned a trust of diagnosis.

The dataset is linked to other registry datasets submitted by trusts to accurately define the studied variables. These include pathology reports, Hospital Episode Statistics (HES) data, the National Radiotherapy Dataset (RTDS), the Systemic Anti-Cancer Dataset (SACT) and the Office for National Statistics (ONS) dataset which provides death certificate data. All patients with a diagnosis of lung cancer (International Classification of Diseases code C34) with pathologically confirmed NSCLC (based on the recorded Systematised Nomenclature of Medicine (SNOMED) codes) and clinically confirmed NSCLC, over the age of 18 years, diagnosed between 01/01/2016 to 31/12/2016 were included. Analyses were restricted to those with stage III using TNM version 7. (18) Patients allocated to a trust in Wales and Guernsey were excluded because linked data to accurately allocate treatment regimens is unavailable. Staging was defined as that recorded by trusts at the time of data input and prior to intervention. For the 2016 cohort of data, lung cancer multidisciplinary teams (MDT's) were contacted by the National Cancer Registration and Analysis Service (NCRAS) with an opportunity to validate their data. (4) 122 trusts (86.5%) requested data and 96 trusts (68.3%) returned validated data. Those that requested data received spreadsheet of patient identifiable data on cases believed to be allocated to their trust. This included cases where no data was

submitted, but NCRAS had received pathology or death data. After receiving validated data from trusts NCRAS updated the NLCA dataset before analysis. In addition NCRAS also perform internal validation of their datasets.

### 4.2.2 Definition of variables

The data cleaning process is described in section 3.2.4. The treatment variables include surgery, radiotherapy, chemotherapy and no active treatment (best supportive care). The modalities are described below:

i. Surgery Surgical operations were identified with the Office of Populations Census and Surveys Classification of Interventions and Procedures version 4 (OPCS-4) codes for each patient indicating thoracic surgical procedure with curative intent. The surgical procedures were categorised as 1) pneumonectomy, 2) lobectomy, including sleeve and bilobectomy, 3) sub-lobar resections, comprising segment and wedges, 4) complex resection and others.

ii. Chemotherapy: Lung cancer specific systemic anti-cancer therapy identified from the SACT database. Patients are allocated to this treatment if a date is recorded with a valid regimen. Chemotherapy is part of a curative regimen if given in conjunction with surgery or radical radiotherapy. If give alone, the intention of treatment is allocated as palliative.

iii. Radical radiotherapy: Identified from the RTDS using a combination of data items including treatment intent, total prescribed dose >50 Gray (Gy) and prescribed number of fractions (10 or more, but with the vast majority delivered 20 or more fractions). If radiotherapy was extra-thoracic, this was not counted in treatment categorisation.

iv. Palliative radiotherapy: A dose of <50 Gy.

Radiotherapy treatments described in RTDS were used to determine if given with radical or palliative intent. Patients allocated to receiving radical radiotherapy alone were defined as receiving radiotherapy at a dose >50Gy alone or with chemotherapy that was delivered >120 days from the date of radiotherapy. In this circumstance, chemotherapy was likely given for disease recurrence or progression. Similarly, patients receiving chemotherapy within 120 days of their date of surgery were classed as receiving adjuvant treatment. The definitions of combination treatments are shown in Table 4.2. Systemic therapy drug names and radiotherapy doses and fractionations were sense checked by an oncologist to ensure that all regimens were commonly used to treat NSCLC and patients had been accurately allocated to the appropriate group.

Chapter 3 shows that patient outcomes are likely to be related to a bundle of organisational factors representing hospital infrastructure. Therefore, to investigate the relationship between hospital service delivery and lung cancer outcomes in patients with Stage III disease, the organisational score described in section 3.3.2 is used as a proxy for hospital infrastructure.

**Table 4.2 Treatment variable definitions**

| Variable | Definition | Calculation |
|---|---|---|
| Surgery alone | Patient received surgery alone OR > 120 days from other treatment | All patients in the cohort population with a valid surgical code receiving no other treatment OR > 120 days date of receiving 'Chemotherapy' AND/OR Radiotherapy.<br>Exclude: Patient received chemotherapy AND/OR any radiotherapy <120 days from surgery date |
| Surgery and adjuvant chemotherapy | Patient received surgery then chemotherapy with a gap of < 120 days | All patients in the cohort population with a valid surgical code AND valid chemotherapy regime < 120 days from date of surgery.<br>Exclude: patient has received radical radiotherapy |
| Neoadjuvant Chemotherapy and surgery | Any patient receiving chemotherapy and then surgery. | All patients in the cohort population with a valid chemotherapy regime followed by a valid surgical date.<br>Exclude: patient has received radical radiotherapy |
| Surgery and curative intent radiotherapy | Any patient receiving surgery and radical radiotherapy OR radical radiotherapy and surgery with a gap of <120 days | All patients in the cohort population with a valid surgical date and valid radiotherapy dose with a gap of <120 days.<br>Exclude: patient has received a valid chemotherapy regime. |
| Triple therapy | Any patient receiving surgery and radiotherapy and chemotherapy in any order. | All patients in the cohort population with a valid surgical date AND a valid radiotherapy dose AND a valid chemotherapy regimen. |
| Curative intent radiotherapy | Any patient receiving curative intent radiotherapy alone or curative intent radiotherapy and chemotherapy with a gap | All patients in the cohort population with a valid radiotherapy dose only OR valid radiotherapy dose first and then chemotherapy regimen with a gap of > 120 days<br>Exclude: 1. Patient has received surgery 2. Patient received chemotherapy < 120 days from radiotherapy 3. Patient received chemotherapy first and then radical radiotherapy. 4. Patient |

| | | |
|---|---|---|
| | of 120 days | received radical radiotherapy and chemotherapy concurrently |
| Concurrent chemoradiotherapy | Any patient receiving curative intent radiotherapy and chemotherapy at the same time or curative intent radiotherapy delivered within 60 days of chemotherapy | All patients in the cohort population with a valid radiotherapy dose and chemotherapy regimen delivered at the same time OR with a gap of <60 days.<br>Exclude: 1. Patient with curative intent radiotherapy and chemotherapy with gap of >60 days 2.) Patients with a valid surgical procedure code. |
| Sequential chemoradiotherapy | Any patients receiving chemotherapy first and then curative intent radiotherapy. | All patients in the cohort population with a valid chemotherapy regimen delivered followed by radiotherapy delivered at a valid dose.<br>Exclude 1.) Patients who had chemotherapy delivered within 60 days of curative intent radiotherapy 2.) Patients with a valid surgical procedure code. |
| Palliative radiotherapy and chemotherapy | Any patient with a palliative radiotherapy dose and chemotherapy regimen | All patients in the cohort population with a palliative radiotherapy dose AND chemotherapy regimen.<br>Exclude: Patient has received curative intent radiotherapy OR surgery |
| Palliative radiotherapy | Any patient with a palliative radiotherapy dose | All patients in the cohort population with a palliative radiotherapy dose.<br>Exclude: patient has received radical radiotherapy OR surgery OR chemotherapy. |
| Chemotherapy alone | Any patient receiving a valid chemotherapy regimen | All patients in the cohort population with recorded valid chemotherapy regimen.<br>Exclude: patient has received radical radiotherapy OR palliative radiotherapy OR surgery. |
| Best supportive care (no treatment) | Any patient who has not received any of the above treatment modalities. | All patients that have not received radical radiotherapy OR palliative radiotherapy OR a valid chemotherapy regimen OR has a valid surgical procedure code. |

### 4.2.3 Covariates

The following variables were identified from the NLCA data: sex, age at diagnosis (split into three groups: <65; 65-80 and >80 years old), socioeconomic status (derived from the postcode and linked with the Index of Multiple Deprivation), Eastern Co-operative Oncology Group (ECOG) performance status (according to the WHO definition) recorded at the time of diagnosis and stage of disease at presentation TNM version 7 (as classified by 'The IASLC Lung Cancer Staging Project'). (18) The HES database was used to calculate the Charlson Co-morbidity Index (a composite score that has been validated for use in this dataset) preceding the date of lung cancer diagnosis. (158) These co-variates were chosen as they are established as affecting patient outcome in lung cancer and have been used in previous studies using the NLCA dataset. (158) Variable definitions are further described in Table 3.3.

### 4.2.4 Outcomes

Two outcomes were measured. The first was curative intent treatment rate defined as patients with stage III NSCLC and a record of a curative surgical procedure or received radiotherapy with curative intent (>50Gy). The second was the proportion of patients alive at one year. Curative intent treatment rate was studied because it is essential to improving overall patient outcomes in this group of patients. Further rationale for outcome variables is described in Table 3.4.

### 4.2.5 Statistical analysis

All data and statistical management were performed by STATA V.14 (StataCorp). Descriptive analyses were conducted for patient and organisational variables. Treatment rates were calculated as per treatment definitions described in Table 4.2 for patients with

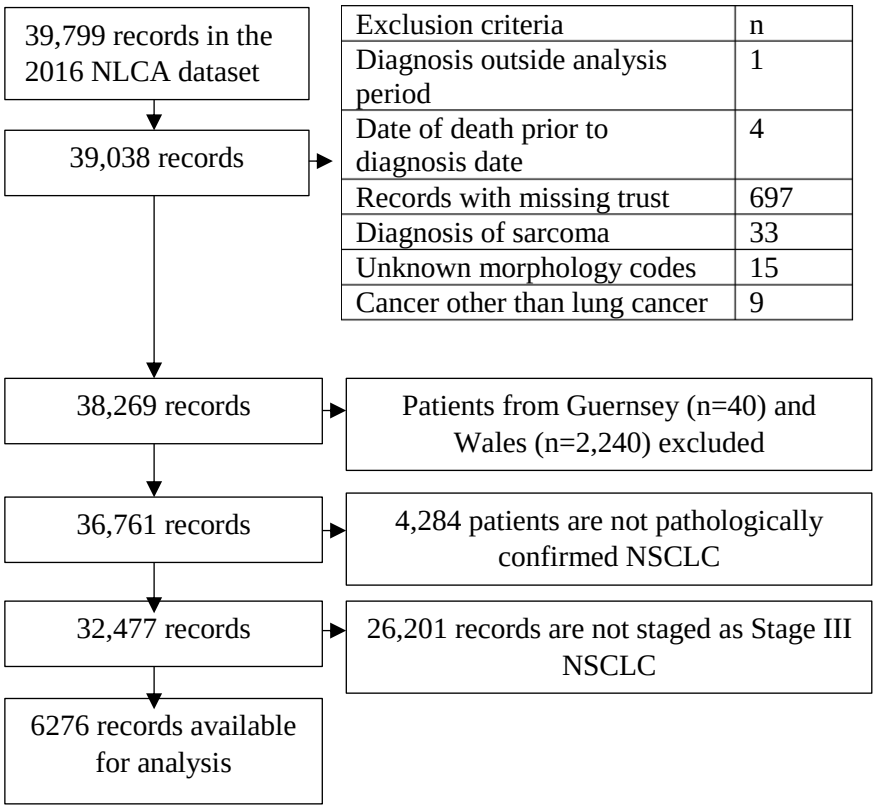
performance status 0-2 with stage IIIA and stage IIIB separately. Adjusted and unadjusted Kaplan-Meier overall survival curves were obtained with survival defined from date of diagnosis to date of death. Adjustment was made for sex, age, performance status and socioeconomic status. Finally, multivariate logistic regression analysis was used to estimate the odds of receiving curative intent treatment and surviving to one year by the organisational score adjusting for patient factors and clustered for NHS trust. Clustering was used to account for the hierarchical nature of the data. To minimise bias resulting from reverse causation, only patient factors known at the time of diagnosis were considered in the final model. The organisational score was categorised into three groups. A p value of $<0.05$ was considered statistically significant.

# 4.3 Results

## 4.3.1 Cohort Definition

36,761 patients were diagnosed with lung cancer between 1 January 2016 and 31st December 2016 and recorded in the NLCA dataset. 6,276 patients with Stage III NSCLC were analysed, 3,827 stage IIIA cases and 2,449 stage IIIB cases. The cohort criteria are illustrated in Figure 4.1.

**Figure 4.1 Cohort flow diagram**




| Exclusion criteria | n |
|---|---|
| Diagnosis outside analysis period | 1 |
| Date of death prior to diagnosis date | 4 |
| Records with missing trust | 697 |
| Diagnosis of sarcoma | 33 |
| Unknown morphology codes | 15 |
| Cancer other than lung cancer | 9 |

The demographics details for patients with stage III disease is shown in Table 4.3. 56.3% of patients were male and 56.7% were aged 65-80 years old. 51.2% of patients have a performance status of 0-1. The median follow-up time from diagnosis was 313 days (10 months) with an interquartile range of 115 days (4 months) to 627 days (20 months).

**Table 4.3 Patient demographics for stage III patients (n=6276)**

| | | Patients(n) | % |
|---|---|---|---|
| **Sex** | Female | 2,746 | 43.8 |
| | Male | 3,530 | 56.3 |
| **Age** | <65years | 1,340 | 21.9 |
| | 65-80 years | 3,559 | 56.7 |
| | >80 years | 1,377 | 21.4 |
| **Stage** | IIIA | 3,827 | 61.0 |
| | IIIB | 2,449 | 39.0 |
| **Performance status** | 0 | 1,158 | 18.5 |
| | 1 | 2,054 | 32.7 |
| | 2 | 1,073 | 17.1 |
| | 3 | 951 | 15.2 |
| | 4 | 235 | 3.7 |
| | Missing | 805 | 12.8 |
| **Townsend quintile** | 1 (most affluent) | 790 | 12.6 |
| | 2 | 1.079 | 17.2 |
| | 3 | 1,229 | 19.6 |
| | 4 | 1,501 | 23.9 |
| | 5 (least affluent) | 1,671 | 26.6 |
| | Missing | 6 | 0.1 |
| **Charlson index** | 0 | 2,511 | 40.0 |
| | 1 | 1,442 | 23.0 |
| | 2 | 1,549 | 24.7 |
| | 3+ | 774 | 12.3 |

### 4.3.2 Treatment patterns

Treatment patterns for stage IIIA and IIIB NSCLC are shown in Table 4.4. 1,860 (30%) patients received therapy with curative intent (surgery or radical radiotherapy) alone or as part of combination treatment. Out of those staged as IIIA, 1,482/3,827 (38.7%) received curative

intent treatment. 770 of these patients underwent surgery, half of which (390 patients) also received chemotherapy, predominately delivered in the adjuvant setting.

1,047 (17%) were treated with radical radiotherapy with 676 (65%) also receiving chemotherapy. For patients receiving chemotherapy and radical radiotherapy where complete dates were available (589 patients), 34% received concurrent chemoradiation (137/366 (37%) stage IIIA) and 66% (229/336 (68%) stage IIIA) received sequential chemoradiation. Where performance status (PS) was available, 171/481 (36%) PS 0-1 cases received concurrent chemoradiotherapy (115/300 (38%) for stage IIIA) and 310 (64%) received sequential chemoradiotherapy (185/300 (62%) for stage IIIA).

Bi-modality treatment with chemotherapy and surgery or radiotherapy with curative intent was delivered to 1123 (18%). 43 out of the 1,123 patients (1%) received tri-modality therapy in either the adjuvant or neoadjuvant setting. 2,265 (36%) people had no record of receiving any active treatment for their stage III lung cancer and 2136 (34%) received treatments of palliative intent. Out of those with stage IIIa disease 1,023 (26.7%) received palliative intent treatment with 1,322 (34.5%) patients receiving supportive care.

4,285 (68%) of patients with stage III NSCLC had a performance status of 0-2. 70% (394/565) of patients with stage IIIA, PS 0-1 and <65 years received curative intent treatment and 56% (671/1,201) in the 65-80 age bracket. 30% (112/390) of patients with stage IIIB, Ps0-1 and <65 years received curative intent treatment with 24% (173/707) in the 65-80 age bracket. Treatment patterns for patients with performance status 0-2 are presented in Table 4.5. 1,671 (39%) received curative intent treatment with a regimen including surgery or curative intent radiotherapy. Out of those staged IIIA 1,322 (51%) received curative intent treatment. 722 (17%) (26% for stage IIIA) had surgery alone or part of multimodality

treatment and 949 (22%) (25% for stage IIIA) had curative intent radiotherapy. Out of the patients that received surgery 56% (431 patients) also received chemotherapy mainly as adjuvant chemotherapy. Multimodality treatment was delivered to 1069 (25%) of patients. Out of these patients 4% received tri-modality therapy. A total of 1,776 (41%) of patients received treatment with palliative intent and 838 (20%) received no active anti-cancer treatment. For those with stage IIIA 32% received palliative intent treatment and 18% best supportive care.

**Table 4.4 Treatment patterns for patients with stage III NSCLC (n=6276)**

| | **Stage IIIA (n=3,827)** | **%** | **Stage IIIB (n=2,449)** | **%** |
|---|---|---|---|---|
| **Group 1: Surgery** | **770** | **20.1** | **43** | **1.8** |
| Surgery | 302 | 7.9 | 19 | 0.8 |
| Surgery and adjuvant chemotherapy | 356 | 9.3 | 12 | 0.5 |
| Neoadjuvant chemotherapy and surgery | 34 | 0.9 | 2 | 0.1 |
| Surgery and radiotherapy | 37 | 1.0 | 8 | 0.3 |
| Triple therapy | 41 | 1.1 | 2 | 0.1 |
| | | | | |
| **Group 2: Radical radiotherapy** | **712** | **18.6** | **335** | **13.7** |
| Radical radiotherapy | 291 | 7.6 | 80 | 3.3 |
| Radical radiotherapy and chemotherapy | 421 | 11.0 | 255 | 10.4 |
| | | | | |
| **Group 3: Palliative intent treatment** | **1023** | **26.7** | **1,125** | **45.9** |
| Palliative radiotherapy and chemotherapy | 182 | 4.8 | 234 | 9.6 |
| Palliative radiotherapy | 396 | 10.3 | 321 | 13.1 |
| Chemotherapy alone | 396 | 10.3 | 570 | 23.3 |
| | | | | |
| **Group 4: Best supportive care (no treatment)** | **1,322** | **34.5** | **946** | **38.6** |

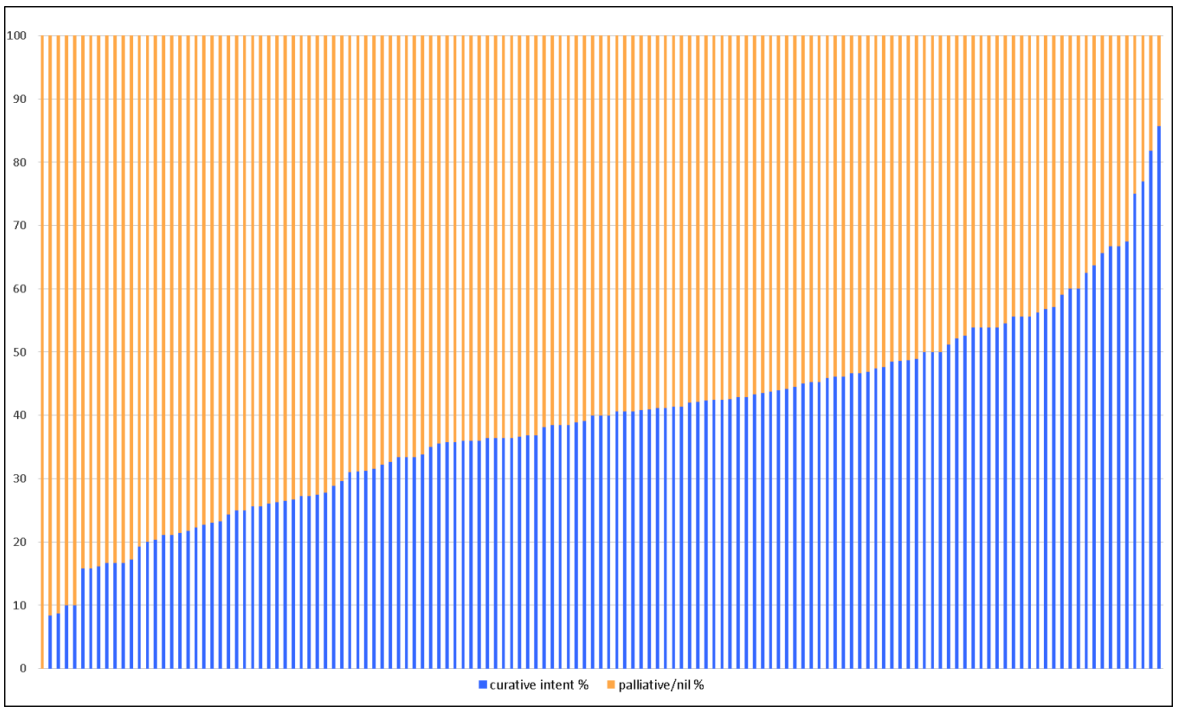
**Table 4.5 Treatment patterns for patients with stage III NSCLC and performance status 0-2 (n=4,285)**

| | **Stage IIIA (n=2,601)** | **%** | **Stage IIIB (n=1,684)** | **%** |
|---|---|---|---|---|
| **Group 1: Surgery** | **684** | **26.3** | **38** | **2.3** |
| Surgery | 260 | 10.0 | 15 | 0.9 |
| Surgery and adjuvant chemotherapy | 314 | 12.1 | 9 | 0.5 |
| Neoadjuvant chemotherapy and surgery | 34 | 1.3 | 2 | 0.1 |
| Surgery and radiotherapy | 34 | 1.3 | 8 | 0.5 |
| Triple therapy | 42 | 1.6 | 4 | 0.2 |
| | | | | |
| **Group 2: Radical radiotherapy** | **638** | **24.5** | **311** | **18.5** |
| Radical radiotherapy | 254 | 9.8 | 73 | 4.3 |
| Radical radiotherapy and chemotherapy | 384 | 14.8 | 238 | 14.1 |
| | | | | |
| **Group 3: Palliative intent treatment** | **822** | **31.6** | **954** | **56.7** |
| Palliative radiotherapy and chemotherapy | 169 | 6.5 | 219 | 13.0 |
| Palliative radiotherapy | 274 | 10.5 | 238 | 14.1 |
| Chemotherapy alone | 379 | 14.6 | 497 | 29.5 |
| | | | | |
| **Group 4: Best supportive care (no treatment)** | **457** | **17.6** | **381** | **22.6** |

### 4.3.3 Regional variation

The variation in use of curative intent treatment for stage IIIA disease with either surgery or radical radiotherapy by NHS trust (anonymised) is shown in Figure 4.2. Rates vary from 8% to 80%. Variation rates were not analysed for stage IIIB due to the heterogeneity of this stage and therefore low likelihood of surgery being offered.

**Figure 4.2 Variation in use of curative intent treatment for stage IIIA by NHS trust**



### 4.3.4 Linkage with organisational score

For the trusts that participated in the organisational audit described in Chapter 3, 5460 (87%) out of all those with stage III NSCLC had an organisational score assigned. The results of the multivariate logistic regression analyses of patient factors and organisational score on curative intent treatment and one-year survival are shown in Table 4.8. For patients from trusts that have a score of 8-11 compared to a score of 0-4, a trend is shown that these patients are more likely to receive curative intent treatment though this did not reach statistical significance. (Adjusted OR (95% CI) = 1.22 (0.83-1.80, p=0.310). There was no significant difference between the groups found in adjusted analyses for one-year survival. Patient factors significantly associated with decreased odds of surviving to one year and receiving curative intent treatment include increasing age and performance status ($p<0.001$ for both).

**Table 4.8 Results of multivariate logistic regression analyses investigating the influence of patient factors and organisational score on curative intent treatment and one-year survival**

| | | One-year survival | | Curative intent treatment | |
|---|---|---|---|---|---|
| | | Adjusted OR (95% CI) | p value for chi squared | Adjusted OR (95%CI) | p value for chi squared |
| Sex | Female | 1.00 | | 1.00 | |
| | Male | 0.91 (0.80-1.03) | 0.142 | 0.95 (0.84-1.07) | 0.372 |
| Age | <65years old | 1.00 | | 1.00 | |
| | 65-80 years | 0.74 (0.64-0.85) | | 0.64 (0.57-0.72) | |
| | >80 years old | 0.55 (0.46-0.66) | <0.001 | 0.27 (0.21-0.34) | <0.001 |
| Stage | Stage IIIA | 1.00 | | 1.00 | |
| | Stage IIIB | 0.56 (0.50-0.63) | <0.001 | 0.24 (0.20-0.28) | <0.001 |
| Performance status | 0-1 | 1.00 | | 1.00 | |
| | 2 | 0.49 (0.41-0.58) | | 0.34 (0.28-0.43) | |
| | 3-4 | 0.25 (0.21-0.30) | <0.001 | 0.05 (0.03-0.07) | <0.001 |
| Townsend quintile | 1 | 1.00 | | 1.00 | |
| | 2 | 1.05 (0.86-1.30) | 0.94 | 0.94 (0.74-1.20) | |
| | 3 | 1.08 (0.87-1.33) | | 0.83 (0.66-1.06) | |
| | 4 | 1.06 (0.87-1.30) | | 1.00 (0.81-1.25) | |
| | 5 | 1.03 (0.84-1.26) | 0.386 | 0.92 (0.74-1.14) | 0.441 |
| Charlson Index | 0 | 1.00 | | 1.00 | |
| | 1 | 0.88 (0.76-1.01) | | 0.91 (0.77-1.07) | |
| | 2 | 0.93 (0.81-1.08) | | 1.00 (0.83-1.13) | |
| | 3+ | 0.79 (0.65-1.00) | 0.780 | 0.96 (0.78-1.17) | 0.675 |
| Organisational | 0-4 | 1.00 | | 1.00 | |
| | 5-7 | 0.96 (0.83-1.12) | | 0.95 (0.71-1.29) | |
| | 8-11 | 1.00 (0.83-1.19) | 0.702 | 1.22 (0.83-1.80) | 0.310 |

### 4.3.5 Survival

Proportions surviving to one year for all stage III patients are shown in Table 4.6. The highest survival is seen for those receiving multimodality treatment. The percentage alive at one year for those that received surgery with chemotherapy (66%) is similar to those that received chemoradiotherapy with curative intent (60%).

The one-year survival for stage III NSCLC was 32.9% (37.4% for stage IIIA). Survival stratified by stage, age and performance status is shown in Table 4.7. 44.7% of patients with performance status 0-1 were alive at one year compared to 14.6% of patients with performance status 3-4. The curative intent treatment rate varied from 45.4% for patients with performance status 0-1 to 3.2% for performance status 3-4. For patients aged <65 years a one-year survival rate of 44 % was found in comparison to 33.1% for those aged 65-80 and 21.6% for patients over the age of 80 years old. Curative intent treatment rates varied from 44.7%, 31.2% to 12.1% for the respective age groups. When stratified by PS0-1, stage IIIA, 54.5% of patients survived to one year if aged <65 years old compared to 42.7% of those aged over 80 years.

**Table 4.6 Proportion alive at one year for patients with stage III NSCLC**

| | **Total patients** | **Patients alive at one year** | **% alive** |
|---|---|---|---|
| Surgery alone | 319 | 151 | 47 |
| Surgery with chemotherapy | 445 | 292 | 66 |
| Surgery and radiotherapy | 44 | 20 | 45 |
| Radical radiotherapy alone | 370 | 157 | 42 |
| Radical radiotherapy with chemotherapy | 675 | 402 | 60 |
| Palliative intent treatment | 2,145 | 695 | 32 |
| Best supportive care | 2,278 | 347 | 15 |

**Table 4.7: One-year survival (%) by age, stage and performance status**

| | One-year survival (%) | Curative intent treatment (%) |
|---|---|---|
| **Overall** | 32.9 | 39.0 |
| **Stage IIIA** | 37.4 | 50.8 |
| **Performance status** | | |
| 0-1 | 44.7 | 45.4 |
| 2 | 25.4 | 19.4 |
| 3-4 | 14.6 | 3.2 |
| **Age group (years old)** | | |
| <65 | 44.0 | 44.7 |
| 65-80 | 33.1 | 31.2 |
| >80 | 21.6 | 12.1 |
| **Stage IIIA & PS 0-1 by age** | | |
| <65 | 54.5 | 69.7 |
| 65-80 | 48.2 | 55.9 |
| >80 | 42.7 | 38.4 |

Unadjusted and adjusted Kaplan-Meier survival curves by treatment received for all stage III cases and for stage IIIA cases are shown (Figures 4.3, 4.4 and 4.5). These data highlights three notable points. Firstly, the survival curves for bi-modality treatment regimens (chemotherapy and surgery versus chemotherapy and radiotherapy) diverge before one year in unadjusted, adjusted and stage IIIA specific analyses, with the highest survival seen for patients receiving the former regimen. Secondly the surgery alone arm crosses the chemoradiotherapy group at just over one year in the adjusted stage III and IIIA analyses. Finally, over this relatively short follow-up timescale, there was no difference in survival identified between people receiving concurrent or sequential radiotherapy (Figure 4.6).

**Figure 4.3 Unadjusted Kaplan Meier survival estimates by treatment group for all patients with stage III NSCLC**

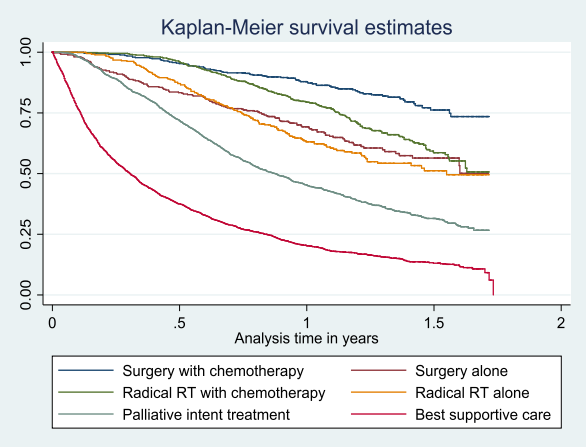


**Figure 4.4 Adjusted Kaplan Meier survival estimates by treatment group for all patients with stage III NSCLC**

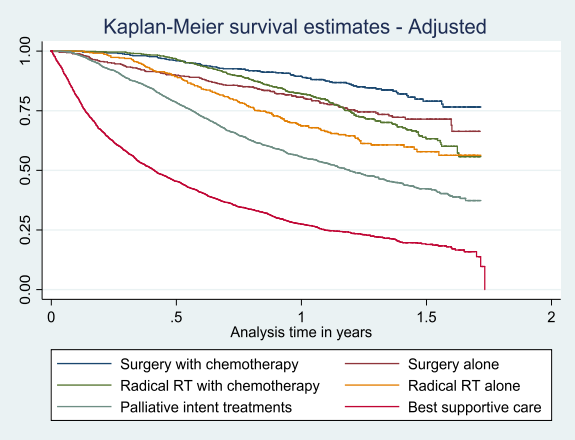


**Figure 4.5 Adjusted Kaplan Meier survival estimates by treatment group for patients with stage IIIA NSCLC**

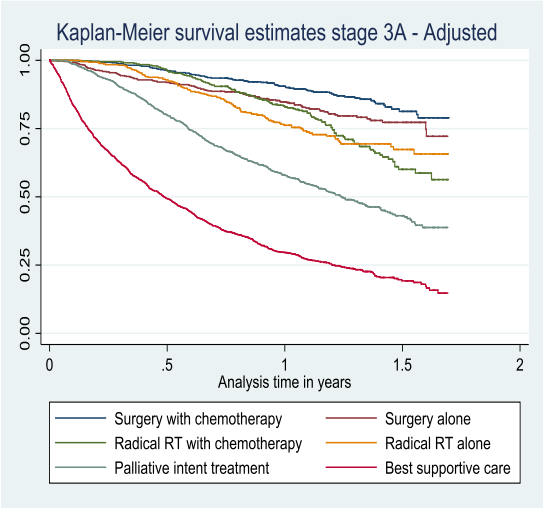
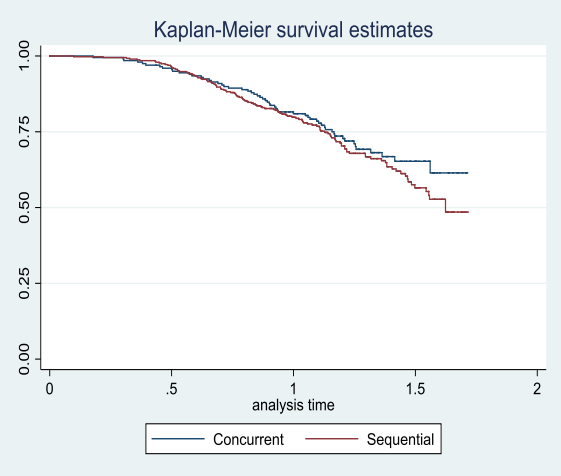


**Figure 4.6 Kaplan Meier estimates for patients with stage III NSCLC receiving concurrent chemoradiotherapy versus sequential.**



## 4.4 Discussion

Stage III NSCLC is a heterogenous disease and can be challenging to optimally treat. This is because patients in this group tend to be elderly with multiple co-morbidities and hence poorly represented in clinical trials. (273) Therefore, there is difficulty applying trial evidence to these patients. To my knowledge this is the first comprehensive analysis of the management of stage III NSCLC conducted in England using population-based data linked with specific radiotherapy and chemotherapy datasets. In addition, the association between hospital infrastructure and lung cancer outcomes is explored. The following section discusses how these findings compare internationally and highlight areas for quality improvement.

### 4.4.1 Summary of findings

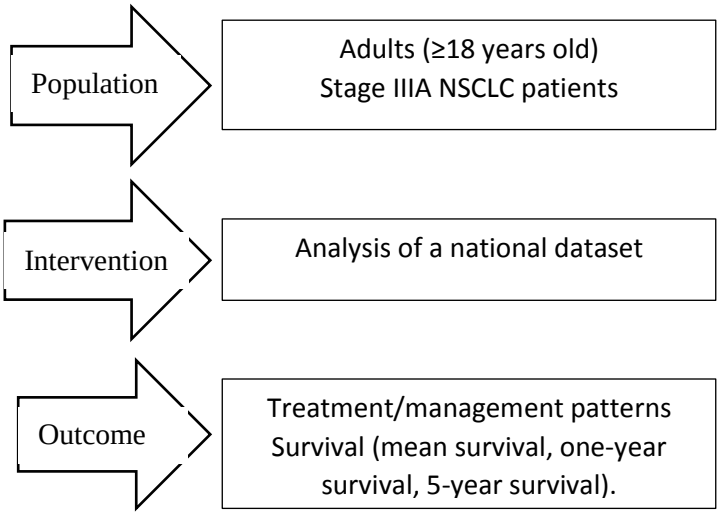
Approximately 40% of stage III NSCLC receive curative intent treatment and about half of all patients with stage IIIA disease. The commonest curative intent regimen is bi-modality treatment (chemotherapy with either surgery or radical radiotherapy), however less than one fifth of patients receive this. One third receive palliative intent treatment or no anti-cancer treatment (36%).

Approximately one third of patients survive to one year (37% for stage IIIA). Patient factors found to be significantly associated with increased likelihood of surviving one year or receiving curative intent treatment include a performance status of 0-2; younger age and stage IIIA. When stratified by age (<65 years old), stage (stage IIIA) and performance status (0-1), about one third of patients receive curative intent treatment and a half survived one year.

### 4.4.2 Comparison with international studies

A literature search for studies investigating the management and outcomes of patients with stage III NSCLC using national datasets was conducted. The following databases were searched for articles published from January 2007 to September 2018 with no language restrictions: PubMed and MEDLINE with the following terms: “non-small cell lung cancer”, “stage III” and “population based” or “database”. All titles/abstracts were reviewed and those that met the inclusion criteria were selected. The selection criteria are summarised in Figure 4.7.

**Figure 4.7 PICO chart detailing inclusion criteria**




This search produced 70 papers that were reviewed using the above criteria. Eleven articles met the criteria from the database search. Table 4.9 summarises the inclusion criteria of these studies. This study represents the most recent analysis of population-based stage III data with other study data varying from as early as 1998 to 2013. Six of the studies were based in the USA (263,276–280), with two from the Netherlands (272,281), and others including British Columbia, Canada (261), Belgium (282) and New South Wales Australia (262). Numbers of

included patients range from 308 to 123,629. The inclusion criteria of five studies were similar to this study of all clinically staged III patients. Two studied the management of stage III disease in the elderly (>65 years) and only included patients where staging was pathologically confirmed. (272,277) Three American studies investigated specific treatment regimens and three only included patients with clinical stage IIIA.

Table 4.10a shows results for this cohort in comparison to studies reporting treatment rates by modality for patients with clinical stage III NSCLC. Driessen et al include those >65 years only. (281) Figure 4.8 graphically illustrates that curative treatment rates in England are the second lowest in comparison to studies from Australia (262), the Netherlands (281) and Belgium (282), lowest for multimodality treatment and highest for patients not receiving any anti-cancer therapy. It should be noted that the study with the lowest curative intent treatment rate (25.9%) only studied four centres in British Colombia, Canada. (261) Vinod et al account for low rates for patients receiving surgery and best supportive care by selection bias. Only 63% of all patients with lung cancer in British Colombia were included. The excluded group had either localised disease with good performance status and therefore likely to have had surgery or metastatic disease with poor performance status and therefore belong to the best supportive care group. Excluding this study, the percentage of patients receiving surgery as part of their treatment (12.2%) is comparable with others that range from 6% in New South Wales, Australia to 13.7% in the USA. (262,263) However, less than one fifth of patients receive radical radiotherapy as part of their treatment compared to approximately half of patients in Australia, USA and the Netherlands. (262,263,281) This is true even though Driessen et al included only patients >65 years in their analysis of the Netherlands Cancer Registry. This corresponds with the comparatively high numbers of patients receiving no active treatment or palliative intent treatment.

**Table 4.9 Selection criteria for population-based studies investigating treatment patterns and outcomes of patients with stage III NSCLC in comparison to this study**

| Study | N | Country | Data date | Data source | Inclusion criteria |
|---|---|---|---|---|---|
| **NLC*A** | **6,276** | **England** | **2016** | **National Lung Cancer Audit and linked datasets** | **Clinical stage III NSCLC** |
| Driessen (281) | 7,057 | Netherlands | 2009-2013 | Netherlands Cancer Registry | Clinical stage III NSCLC; age 65 years or older |
| Vinod (261) | 2,365 | British Columbia (BC), Canada | 2000-2007 | BC Cancer Agency database (data from four cancer centres) | Clinical stage III NSCLC |
| Vinod/O'Connell (262) | 308 | New South Wales (NSW), Australia | 2001-2002 | NSW Central Cancer Registry | Clinical stage III NSCLC |
| Verleye (282) | 1,987 | Belgium | 2010-2011 | Belgian Cancer Registry | Clinical stage III NSCLC |
| Little (263) | 11,263 | USA | 2001 | National Cancer Database | Clinical stage III NSCLC |
| MacClean (279) | 18,684 | USA | 2006-2012 | National Cancer Database | Pathologically confirmed Stage III NSCLC who received surgery and neoadjuvant/adjuvant chemotherapy |
| Harris (276) | 1,943 | USA | 2002-2009 | Medicare-SEER database | Pathologically confirmed stage III NSCLC, aged >65 years who received chemoradiotherapy |

| | | | | | |
|---|---|---|---|---|---|
| Miller (277) | 57,602 | USA | 2003-2014 | National Cancer Database | Clinical stage III NSCLC |
| Dickhoff (272) | 4,816 | Netherlands | 2010-2013 | Netherlands Cancer Registry | Clinical stage IIIA NSCLC |
| Patel (280) | 123,629 | USA | 1998-2010 | National Cancer Database | Clinical stage IIIA NSCLC who received chemoradiotherapy or chemotherapy, surgery and radiotherapy (in any sequence) only. |
| Hancock (278) | 83,913 | USA | 1999-2011 | National Cancer Database | Clinical stage IIIA NSCLC |

**Table 4.10a: Comparative published treatment rates by modality for Stage III patients**

| | **NLCA (n=3,827)** | **Vinod/O' Connell** (262) **(n=1,812)** | **Little** (263) **(n=11,168)** | **Driessen*** (281) | **Verleye** (282) **(n=1,987)** | **Vinod** (261) **(n=2,365)** |
|---|---|---|---|---|---|---|
| **Surgery alone** | 5.1 | 4.0 | 6.6 | 9.5** | 11.7** | 4.5 |
| **Surgery with chemotherapy** | 7.1 | 2.0 | 7.1 | | | 4.6 |
| **Radical radiotherapy** | 5.9 | 31.0 | 16.5 | 35.9 | 6.6 | 3.5 |
| **Radical radiotherapy with chemotherapy** | 10.8 | 19.0 | 36.2 | 14.5 | 33.9 | 13.3 |
| **Curative intent therapy** | 28.9 | 56.0 | 66.4 | 59.9 | 32.8 | 25.9 |
| **Multimodality treatment** | 17.9 | 21.0 | 43.3 | 14.5 | 52.1 | 17.9 |
| **Palliative intent treatment** | 34.2 | 11.0 | 11.5 | 13.4 | 32.8 | 61.0 |
| **Best Supportive Care** | 36.1 | 28.0 | 18.5 | 26.5 | 15.4 | 10.5 |

*Patients>65 years old only included
**Results not reported separately

**Figure 4.8 Treatment pattern by country for stage III NSCLC**

BSC: Best supportive care; BC: British Colombia

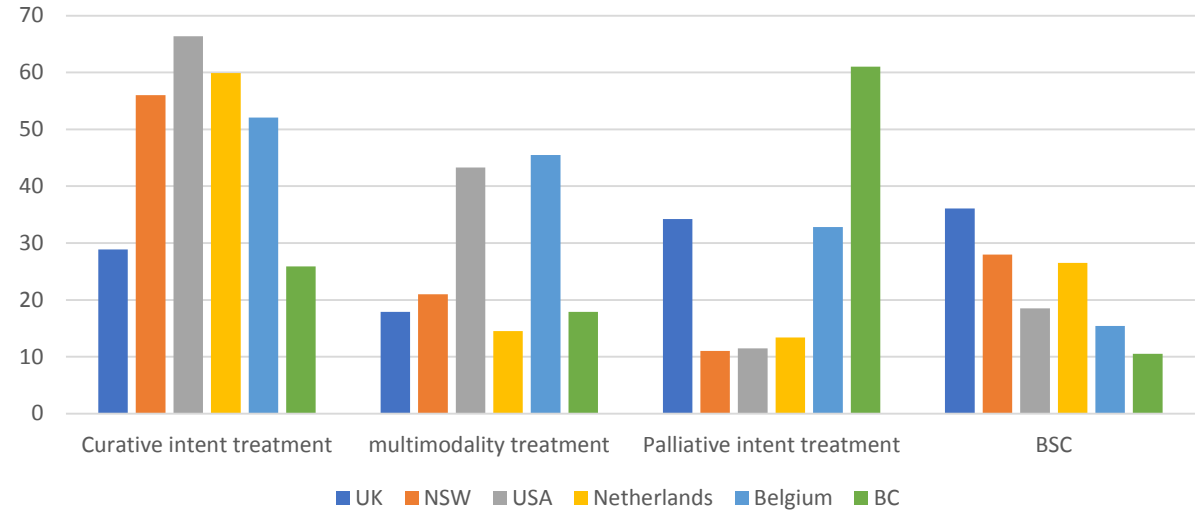


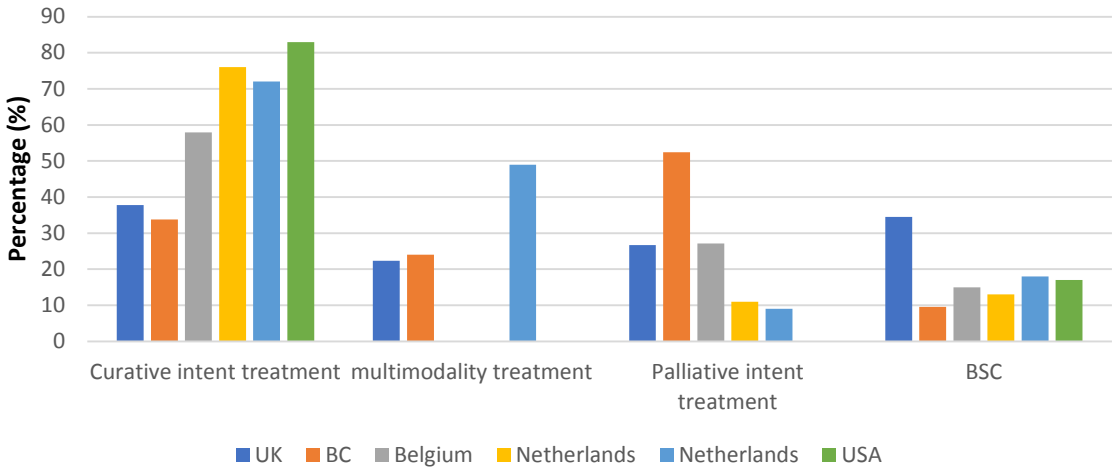

Table 4.10b compares treatment patterns in the NLCA dataset to studies that reported management of patients with clinical stage IIIA. Figure 4.9 shows that excluding the study by Vinod et al, curative intent treatment rates remain the lowest for England in comparison to the Netherlands (281), Belgium (282) and USA (278). The same pattern as that shown in Figure 4.8 for all stage III patients is seen for stage IIIA too. Surgical resection rates are comparable:- 19.2% in England compared to 17% in Belgium (282), 21% and 15% in the two studies from the Netherlands (272,281) and 14% in the USA (278). However, radical radiotherapy rates remain low for stage IIIA (18.6% for England, 40.9% in Belgium (282), 55%/57% for the Netherlands (272,281) and 69% in the USA (278)). Over one third of patients at stage IIIA do not receive any active treatment which compares to 13%-18% in the other studied countries. (272,278,281,282)

**Table 10b: Comparative published treatment rates by modality for Stage IIIA patients**

| | **NLCA (n=3,827)** | **Vinod** (261) | **Verleye** (282) **(n=1,197)** | **Driessen*** (273) **(n=3,960)** | **Dickhoff** (272) **(n=4816)** | **Hancock** (278) **(n=83,913)** |
|---|---|---|---|---|---|---|
| **Surgery alone** | 7.9 | 5.8 | 17.0** | 21.0 | 11.0 | 14.0** |
| **Surgery with chemotherapy** | 11.3 | 7.5 | | 47.0 | 4.0 | |
| **Radical radiotherapy** | 7.6 | 4.0 | 8.1 | 8.0 | 12.0 | 69.0** |
| **Radical radiotherapy with chemotherapy** | 11.0 | 16.5 | 32.8 | 11.0 | 45.0 | |
| **Curative intent therapy** | 37.8 | 33.8 | 57.9 | 76.0 | 72.0 | 83.0 |
| **Multimodality treatment** | 22.3 | 24.0 | NR | NR | 49.0 | NR |
| **Palliative intent treatment** | 26.7 | 52.4 | 27.1 | 11.0 | 9.0 | 17.0 |
| **Best Supportive Care** | 34.5 | 9.6 | 15.0 | 13.0 | 18.0 | NR |

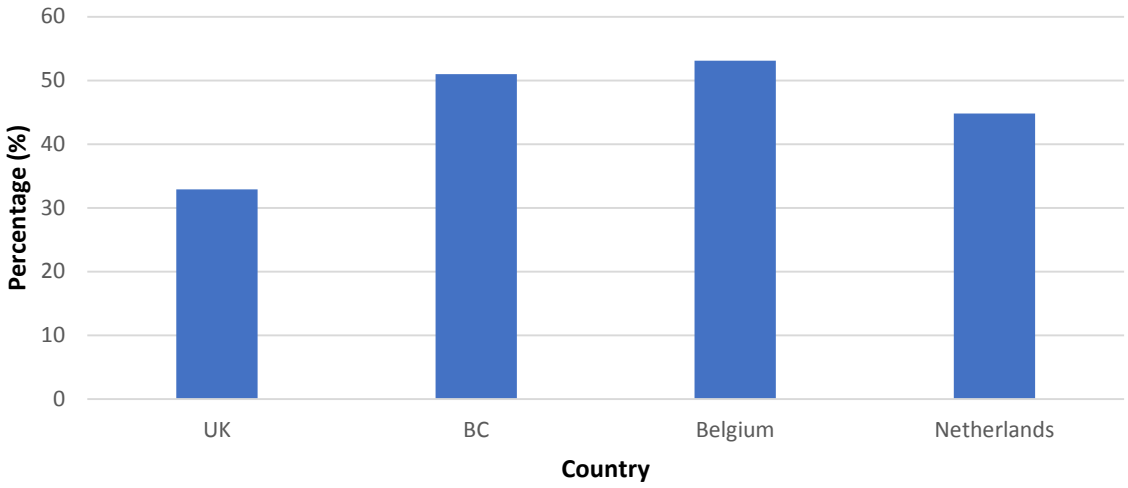
NR: Not reported separately
*Patients>65 years old only included
**Results not reported separately.

**Figure 4.9 Treatment pattern by country for stage IIIA NSCLC**
UK: United Kingdom; BC: British Colombia; BSC: Best supportive care




The one year survival rate of 33% reported in the current study does not compare favourably to other studies (British Colombia (51%) (261), Belgium (53.1%) (282) and the Netherlands (44.8%; patients >65 years only) (281)) shown in Figure 4.10. The rate of 55% found in the optimised subgroup (<65 years, PS 0-1 and stage IIIA) is consistent with international data. These figures may be reflective of the high rates of patients not given any active anti-cancer treatment or treated with palliative intent. However, NLCA data includes all lung cancer cases diagnosed in England. Therefore, it is important to note that the total number of cases is likely to be larger than in other reported series.

**Figure 4.10 One-year (unadjusted) survival by country (%)**
UK: United Kingdom; BC: British Colombia




## 4.4.3 Reasons for international differences in treatment patterns and survival

Reasons for these comparatively low outcomes are likely to be multifactorial including patient, tumour, clinician and organisational factors. These factors are discussed in turn below.

### 4.4.3.1 Patient factors

Patient factors cannot wholly explain our findings. The demographics in this cohort are shown to be similar to other lung cancer populations from Western countries in terms of age and performance status. (92,261,263,283)

Patients included in the NLCA dataset were found to have a lower co-morbidity burden than in other studied populations. Eighty percent of the Australian population in the study by Vinod et al and 72% of the cohort in Little et al had at least one co-morbidity. This compares to only 60 % in the NLCA population. Charlson Index was used as a proxy for co-morbidity

burden. This composite score has been validated in cohorts of men and women with malignant and non-malignant diseases. (284) Studies using NLCA data derive this index from hospital admission data, therefore all diagnoses may not be captured if a condition is managed by a general practitioner. This may explain our comparatively low co-morbidity burden and raises the possibility of residual confounding. (158) Despite this, the methodology used to derive the score has been validated for use in the NLCA cohort. (158) Furthermore, the distribution of the index is similar to general practitioner datasets (285) and cohorts of patients with NSCLC. (286,287) Comparative international data on deprivation index is lacking.

In the multi-variate analysis, the presence of co-morbidity did not independently affect the likelihood of treatment or one-year survival. This is in keeping with findings from other stage III studies. (262,288) This may be because the majority of patients had a good performance status despite the presence of co-morbidities. (262)

Patient factors that were found to be significantly associated with improved one-year survival or curative intent treatment on multivariate analyses were a performance status of 0-2, younger age (<65 years) and stage IIIA. However, approximately one third of patients in this optimised group did not receive curative intent treatment suggesting that treatment decisions are influenced by factors other than patient and tumour variables.

4.4.3.2 Clinician factors

Clinician factors may explain the high proportion of patients receiving palliative intent treatment or no active treatment. Qualitative work conducted in early stage NSCLC demonstrates that a failure of clinicians to effectively discuss all treatment options with patients influence treatment rates. (289) Additionally, Legare et al show that the most

significant variable determining whether patients will engage in shared decision making is the clinicians attitude and there is evidence to show that differences in attitudes towards the management of this specific stage exist amongst health professionals. (290)(291) Hence it is possible that nihilistic attitudes amongst health professionals may contribute to our low radical radiotherapy and multimodality treatment rates. Such attitudes among respiratory physicians may contribute to low referral and pathological confirmation rates. (292) Similarly, a fatalistic attitude amongst treating clinicians may limit receipt of treatment. (293,294)

One factor that has been shown to significantly influence treatment decision making is age. (281) Previous studies demonstrate that elderly patients with NSCLC receive standard treatment less often. (281) Table 4.7 shows that amongst patients with a PS of 0-1 and stage IIIA in England, the rate of curative intent treatment varied from 70% in the <65 age bracket to under 40% in >80-year olds. Additionally, on multivariate analysis, the odds of receiving treatment in patients over the age of 80 were 70% less likely than those <65 after accounting for other patient factors. This finding is consistent with the literature. (277,281) Previous analysis of the NLCA showed that the odds of being investigated and treated decreased progressively with age. (295) Additionally, Miller et al show that patients with stage III disease over the age of 70 years old were twice as likely not to receive any treatment and 1.4 times more likely to receive palliative intent treatment if treatment was received compared to those under 70 years old. (277) In addition, when curative intent treatment was delivered, elderly patients were three times more likely to receive radiotherapy alone rather than multimodality treatment.

These findings can be explained by multiple factors. Firstly, there is a lack of evidence to base treatment decisions because elderly patients are under-represented in clinical trials. (296) In addition, other factors such as patient preferences, malnutrition and cognitive impairment are

likely to be important. (281) Lastly, elderly patients are shown to be particularly vulnerable to acute severe toxicities resulting from multimodality treatment such as oesophagitis, haematological toxicity and pneumonitis. (273,297–299) Therefore, morbidity concerns are likely to significantly influence treatment decision making. Nevertheless, the literature suggests that current criteria applied to decision making may be too strict, leading to a suboptimal number of patients receiving curative intent treatment. Driessen et al show that mortality for stage III patients does increase with age, but these differences are rendered insignificant once stratified by treatment. (281) Additionally there is evidence that older patients with similar clinical features to a younger age group can tolerate and equally benefit from investigation and treatment. (295) Finally, a statement by the European Organisation for Research and Treatment of Cancer states that suitability for treatment should not be defined by chronological age alone. (300)

Four interventions have the potential to address such variability in decision making. The British Thoracic Society recommend providing patients with surgical and oncology treatment assessments by the relevant teams. (265) Widespread implementation of this approach has the potential for quality improvement interventions to address two findings. Firstly, the low number of patients receiving multi-modality treatment including neoadjuvant or tri-modality therapy in surgical patients, which currently sits at just 10%. Secondly the high numbers of patients (n=321) receiving surgery alone; a treatment approach not supported by evidence or guidelines. This is pertinent given the updated NICE lung cancer guidelines newly advocate chemoradiotherapy prior to surgery in multimodality stage IIIA treatment; a practice that is clearly not currently executed. (41) However, it should be noted that the definition of radical radiotherapy in this study is >50 Gy which is higher than what be used in practice in a tri-

modality regimen. Additionally, factors such as patient preference and decline in patient performance status post-surgery may explain this finding.

Secondly, the use of comprehensive geriatric assessment (CGA) as described in the scoping review in section 2.1.5.2 can provide a structured approach to holistic patient assessment. Hence, ensuring those suitable for curative intent treatment are fully informed of their treatment options whilst avoiding overtreatment. Schulkes et al found in their systematic review of the use of the CGA tool in elderly patients with NSCLC that it can help detect health concerns not reflected by performance status alone and predict mortality and treatment completion. (301)

Thirdly, this registry-based data reported in the current study includes all stage III NSCLC patients diagnosed in England and some will be too unwell or frail for treatment and many will not be surgical candidates. However, the variation across hospital trusts in the proportion of patients treated with either surgery or radical radiotherapy would suggest that as a country, there is room to increase the amount of radical radiotherapy offered to stage III patients and to critically review how this is given in combination with chemotherapy. This is particularly relevant in light of a recent trial showing significantly improved overall survival with the addition of adjuvant Durvalumab after concurrent chemoradiotherapy. Out of all patients receiving chemoradiotherapy only one third had this is the concurrent setting. This compares to rates of 94% in USA and 92% in Canada. (261,276) Therefore, large change in practice is required if adherence to the latest NICE guidance is to be achieved. Understanding barriers to access and re-evaluating preconceptions of what is considered radically encompassable with the use of modern radiotherapy techniques such as intensity modulated radiation therapy (IMRT) may improve low radical concurrent radiotherapy rates. Koshy et al  demonstrated that patients with stage III NSCLC treated with IMRT had an eleven per cent relative

reduction of risk of death compared to those treated with non IMRT techniques. (302) Additionally, the former group had a lower incidence of treatment interruptions. Another study showed that IMRT is associated with lower rates of severe radiation pneumonitis. (303) Therefore, the reduced mortality and morbidity associated with this technique indicates that elderly patients may be better able to tolerate curative intent treatment. One barrier may be that encompassability can only be adequately assessed with planning attempts to ascertain dose and volume data. Therefore, these attempts require reimbursement even if patients do not progress to receive a radical dose.

Finally, improvements in consistent performance status assessment is crucial to determining appropriate management plans. Studies report conflicting data in the reliability of clinician assessed performance status measurement with variable levels of inter-observer agreement. (304–306) Additionally, the recorded measurement tends to that assessed on initial presentation rather than that at the time of assessment by a treating clinician. This inconsistency is likely to have an impact on results and is explored further in section 5.3.3.3.

4.4.3.3 Organisational factors

There is an increasing body of literature indicating that organisational characteristics and access to specialist care significantly impacts patient outcomes and contributes to national variation. (261,282,307) Therefore, even though the association between the organisational score and lung cancer outcomes did not reach statistical significance for stage III patients, this factor still warrants further discussion.

Access to up to date staging modalities is key in stage III NSCLC. Details of the extent of staging is not available in the NLCA dataset. However, with endobronchial ultrasound being available on site in England in only 67% of trusts combined with the fact that 102 trusts fall

below the 75% target for pathological confirmation; patients run the risk of missing out on potentially curative treatment. (214) The latest NLCA report reports a pathological confirmation rate of 72% which compares to a figure of 91% quoted by Vinod et al in their Australian cohort.(262)

Similarly, limited access to treatment facilities can influence treatment receipt. Verleye et al found that in their study of NSCLC patients in Belgium, that important differences between institutions were observed. (282) Organisations that had on site radiotherapy facilities treated a higher proportion of stage III patients with chemoradiotherapy. Therefore, the variability in access to surgical and radiotherapy shown in Chapter 3 is likely to have an influence on treatment patterns.

Another factor is inequity of access to specialist staff shown by the second NLCA organisational audit. (214) Lung cancer CNSs have been shown to be key in enhancing communication and patient decision making yet less than a fifth of trusts meet the lung cancer national commissioning guidance requirement of having a minimum of one whole time equivalent specialist nurse per 80 new lung cancer diagnoses per year. (214,255,308) It is not possible to ascertain from the data if patients consulted specialist health professionals. However, there is UK evidence to show that patients that see a lung CNS or an oncologist are more likely to receive active treatment. (255,309) This is in line with SEER data from the USA showing that 36% of patients who did not receive chemotherapy for their advanced lung cancer were not seen by a medical oncologist. (310) Therefore, difficulty with access to specialist staff is likely to be a barrier to a patient receiving optimal treatment.

Lastly, timeliness of access to facilities is important as emphasised by national guidance. (86,227) Lung cancers can progress, and the performance status of patients can drop in the

waiting time for diagnostics, advice and treatment. (311) This is particularly important for this subgroup of patients who frequently require additional staging investigations and complex treatment planning. (292,311,312) Timely access to specialist facilities is essential if improvements are to be made which can be achieved through adoption of the national optimal lung cancer pathway. (86)

Despite the above evidence, we show that a higher organisational score was not statistically significantly associated with improved one-year survival or curative intent treatment rates in this subgroup unlike for the overall population shown in Chapter 3. This highlights the importance of other factors that are likely to contribute to treatment patterns for this cohort discussed above. The management of stage III patients is complex. Hence factors such as therapeutic nihilism, over estimation of risks of treatments by clinicians and uncertainty on the extent of information patients receive to base decisions on, all play a part in influencing treatment patterns; factors not fully encompassed by the organisational score.

In summary, improving outcomes for patients with stage III disease in England requires a multi-faceted approach. Undertreatment has the potential to be addressed by specialist MDT's for complex stage III patients and training in optimal patient selection. However, financial investment in lung cancer services and deficiencies in service structure require urgent attention to enable timely access to essential diagnostic and therapeutic modalities to ultimately change patient outcomes.

### 4.4.4 Strengths and limitations

The main strength of this study is the completeness and quality of the NLCA data providing an accurate picture of patient management in this subgroup. In fact, the accuracy and validation of UK data may contribute to reasons why our results compare poorly to others. It

is important to note that NLCA data includes all lung cancer cases diagnosed in England, therefore the proportion of all patients whose data is included is likely to be larger than other reported series.

Four main limitations should be acknowledged. Firstly, the retrospective nature of the population-based data may be subject to confounding, under-reporting and selection bias. Selection bias may in part explain why treatment regimens involving surgery are shown to have better survival than the other curative intent regimens. These patients may represent a fitter group or more accurately staged intraoperatively. Secondly, as previously mentioned, details on the quality of staging or the tumour volume or location is not available in the NLCA dataset, therefore eligibility for curative intent treatment and details of stage designation cannot be verified. Thirdly, only short-term survival was examined because linked data has only recently been available to allow accurate treatment allocation. However, one-year survival has been shown to be an important driver in longer term survival. (313) Finally, it is not possible to ascertain the reasons for treatment decisions from population-based data. Further understanding into decision making practices in lung cancer will increase our understanding of barriers to patients receiving optimal treatment. This will be addressed in the following chapter.

## 4.5 Conclusions

We highlight important gaps in the optimal care of patients with stage III NSCLC. Establishing current treatment patterns is important at this pivotal era of immunotherapy. Significant improvements in progression free survival seen with the addition of Durvalumab to chemoradiotherapy in stage III disease heralds a treatment paradigm shift. However, without addressing deficiencies in care, only 4% of our patients would currently benefit from such advancements. (76) Timely access to specialist resources and staff, the practice of effective shared decision making, and challenging preconceptions require urgent attention to address regional variation in curative intent treatment if patients are to have the best chance of surviving this disease.

# CHAPTER 5 DECISION MAKING IN LUNG CANCER: A LOCAL QUALITATIVE STUDY

## 5.1 Introduction

Outcomes in lung cancer are known to be influenced by patient factors and provision of resources. However, hospital trusts that have similar patient populations and resource allocation have shown variation in outcomes. (17) It has been hypothesised that outcomes are also dependent on the quality of decision making that occurs within the multidisciplinary team (MDT) of that hospital. This type of detailed information is not captured by large datasets such as the NLCA due to the complexity of the data that would be required. However, addressing barriers to effective decision making locally is likely to have a direct impact on patients.

The following chapter critically examines the process of lung cancer MDT decision making with a focus on shared decision making (SDM) in one hospital trust with the aim of developing an implementation strategy to identify and address areas of improvement.

### 5.1.1 Models of decision making in healthcare

The three most commonly referenced models of decision making in healthcare are paternalistic, shared and informed summarised in Table 5.1. (314) Previously, the most prevalent model was paternalistic. (314) This is where the physician drove decisions according to their experience, expertise and assumptions about the patient. Models involving collaboration with patients have gained popularity over recent years however the paternalistic model of consultation is still that most widely practiced by healthcare professionals. (315)

**Table 5.1 Models of decision making**

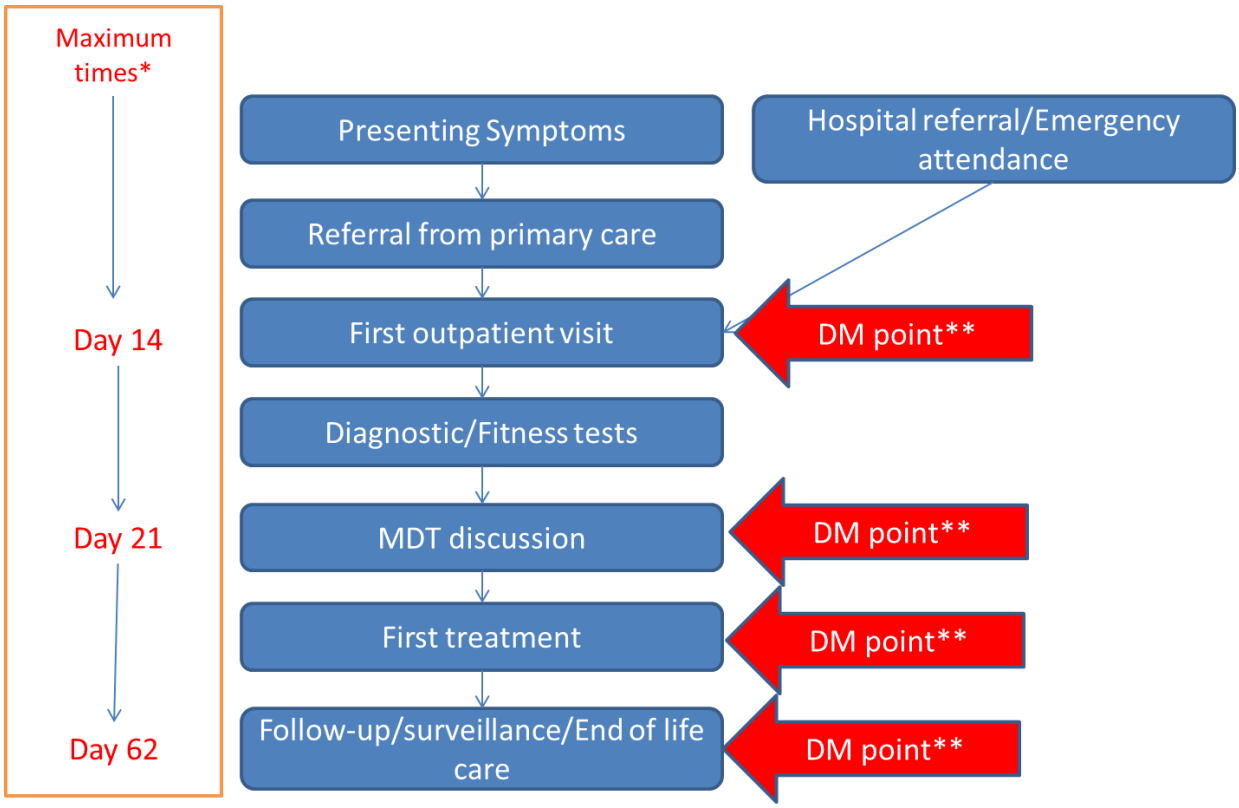
| | **Paternalistic** | **Shared** | **Informed** |
|---|---|---|---|
| Consultation style | Directed by physician | Physician and patient contribute | Directed by physician |
| Decision maker | Physician | Physician and patient | Patient |
| Associated health model | Biomedical[1] | Biopsychosocial model[2] | Bio medical |

[1] Biomedical model of disease is focused on physical and biological factors of disease(316)
[2] A wide range of factors are considered in the biopsychosocial model of health including a person's social circumstances, beliefs and values.

## 5.1.2 Factors influencing decision making in lung cancer

Clinical decision making in lung cancer is a complex process. Figure 5.1 illustrates a 'typical' patient journey and indicates points where decision making may occur. Time targets are highlighted as per the 'Independent Cancer Taskforce Report' which was formulated to reduce delays and increase treatment utilisation. (94)

**Figure 5.1 Patient pathway and decision-making points**



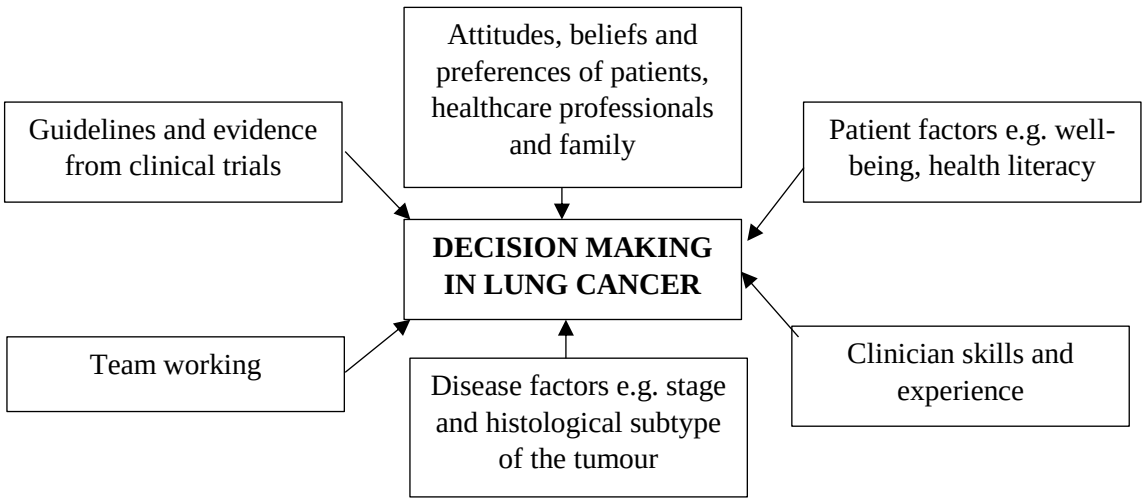

* Maximum pathway times according to the Independent Cancer Taskforce Report. The times are the maximum allowed but the National Optimal Lung Cancer Pathway aims for the majority of patients to be diagnosed within 28 days and treated within 42 days.

** DM point: Decision making point

Figure 5.2 summarises factors that are known to influence decision making in lung cancer. Decisions in lung cancer are heavily influenced by guidelines such as the NICE guidelines ("The diagnosis and treatment of lung cancer") and the aforementioned "National Optimal Lung Cancer Pathway" document produced by the Lung Clinical Expert Group in 2017. (86,227) These recommendations provide the basis of the best available evidence of clinical and cost effectiveness for health care professionals and patients to make decisions in lung cancer.

Factors other than clinical guidelines that are known to influence decision-making are patients' medical history and tumour characteristics. (315) This may include the patients' age, diagnoses, co-morbidities and prior treatments as well as the tumour stage, radiological and histological results. This information is key to assessing the options available for a patient with lung cancer. Additionally, knowledge and beliefs of both patients and health care professionals impact on decision making in cancer. (317) Patients' knowledge of treatment options and disease are affected by the way in which clinicians' beliefs are expressed as well as the way the risks of benefits of potential options are presented to them. (317) Factors such as health literacy, symptom burden as well as past experiences of the clinicians' have also been shown to play a part in decision making. (315,318,319)

**Figure 5.2 Factors influencing decision making in lung cancer**




## 5.1.3 The MDT meeting

It has been shown that the majority of cancer decision making occurs in the MDT meeting. (320) The MDT meeting was introduced after the Calman-Hine report documented poor outcomes for cancer patients. (321) The aim of the MDT meeting is to address variation in

care across UK and improve decision making by involving several health care professionals. It is recommended by the National Comprehensive Cancer Network and in 2001 The NHS Cancer plan committed to ensuring that all patients with cancer were reviewed by a tumour specific MDT. (322) It is now established as the standard of care for patients with cancer in the UK.

Guidelines mandate that membership of the lung cancer MDT should include at least one of the following specialists: a respiratory physician with an interest in thoracic oncology, a radiologist and histopathologists with thoracic experience, a clinical nurse specialist, clinical and medical oncologists, a palliative care physician, a thoracic surgeon and an MDT administrator. (323–326) All these specialists should attend the MDT meeting for it to be considered quorum.

All patients with a confirmed or suspected diagnosis of lung cancer are discussed at the MDT meeting. The first organisational audit recommended that MDTs should hold two meetings per week; a diagnostic and treatment MDT. (85) A diagnostic MDT attended primarily by respiratory physicians and a thoracic radiologist discusses the initial optimal approach at the start of the patient pathway. The treatment MDT predominately discusses treatment decisions for patients with a histological diagnosis. However, discussions may also include post-operative outcomes and re-discussion of patients if situations or circumstances have changed. The inclusion of the ‘diagnostic MDT’ as a separate meeting aims to maximise resources by avoiding unnecessary investigations and therefore minimising delays to treatment.

### 5.1.4 Shared Decision Making

SDM is defined as the "interactional process in which the patient and the clinician aim to reach a decision together that is based on shared information and the best available evidence". (327) SDM underpins patient centred care because it helps patients understand their disease and consider the benefits and harms of proposed treatment options in terms of their own context, values and beliefs. (315)

5.1.4.1 The process of SDM

Experts in SDM advocate a step wise approach to facilitate decision making in an oncology setting. These steps are summarised in Table 5.2. (328)

**Table 5.2 Steps in the Shared Decision-Making Process**

| **Steps** | **Shared Decision-Making Action** |
|---|---|
| 1 | Determine the situations in which SDM is critical |
| 2 | Acknowledge the decision to the patient |
| 3 | Describe the options, risks, benefits and uncertainty associated with options |
| 4 | Elicit patient preferences and values |
| 5 | Agree on plan for the next steps in the decision-making process. |

5.1.4.2 Evidence supporting SDM

SDM is supported by several national and international bodies. An international group at the Salzburg global seminar advocated for clinicians, patients and policy makers to support SDM. (329) The principle of "No decision about me without me" adopted at this seminar has been embraced by national guidelines in the UK promoting the use of SDM in routine care. (330)

There is a growing body of evidence demonstrating the benefits of SDM. Studies have established that patients who experience SDM have more accurate expectation about care,

decreased levels of fear and depression, improved quality of life and increased treatment satisfaction. (331–334) Importantly, patients want to be involved in management decisions. There is evidence demonstrating that decisions made by such patients differ to decision made by patients that experience other consultation models. (290,335,336) These decisions are also shown to differ from those made by treating clinicians. (337). These may be because medical professionals and patients have been shown to vary in their interpretation of risk or the value of survival and quality of life is judged differently. (334,335) Therefore, it is evident that SDM is not only an essential component of patient centred care but also an ethical imperative. (338,339)

5.1.4.3 Challenges incorporating SDM in clinical care

Two main challenges impeding the routine application of SDM have been summarised in Table 5.3.

**Table 5.3 Challenges incorporating SDM in clinical care**

| **Issue** | **Challenge** | **Consequence** |
|---|---|---|
| Biomedical model of disease and paternalistic style of consultation is predominant model of practice in healthcare(315,340). | - Changing organisational culture and attitudes is challenging. (341)<br>- Patients are not present in the MDT meeting. | - Decisions reflect the values of MDT members rather than patients<br>- Agreed MDT outcomes can be framed by the clinician communicating the information to the patient |
| Burden of decision making is on the patient | - Patient decisions are dependent on several factors such as family pressures, emotional state and ability to interpret information. (342)<br>- Clinicians require time to adequately assess if the decision truly reflects the values and opinions of the patient | - Resources are lacking in the NHS to dedicate such time.<br>- Shorter lung cancer pathways are linked to improved patient outcomes. (343) Delaying treatment decisions may not be in a patient's best interests. (210)<br>- no robust mechanism to judge the extent to which he decision is informed or free from coercion. (338) |

#### 5.1.4.4 Shared Decision Making in Lung Cancer

SDM is relevant to lung cancer for three main reasons. Firstly, the lung cancer trial population is not representative of real life, as discussed in section 4.1.3. Consequently, shared decision making is vital to ensure patient priorities are met. This is particularly important in clinical situations where the optimal management is uncertain. (344) The management of stage IIIa (N2) disease discussed in chapter 4 is one such clinical scenario. Another situation of clinical equipoise is the treatment of early stage NSCLC in patients with a good performance status as discussed in section 1.6.2. In these preference sensitive decisions, actively involving the patient provides personalised treatment and better outcomes. (340)

Additionally, clinical trials introducing novel treatments for lung cancer patients are occurring more frequently than ever. For example results of the recent PACIFIC trial presented at the latest 'World Conference on Lung Cancer' has shown promising survival gains with the use of Durvulumab (an immunotherapy agent) in patients with stage III unresectable lung cancer when used after chemoradiotherapy. (246) The increase in treatment options is clearly good news for patients. However, the risks, benefits and effectiveness of such new treatments are yet to be established. Therefore, communicating this uncertainty to patients and involving them in decisions is necessary.

Finally, lung cancer has a median prognosis of one year. (3) A diagnosis is associated with psychological distress and poor quality of life. SDM allows patients to be guided through difficult risk benefit calculations that are life changing. (345)

Despite the relevance of SDM practice to good lung cancer management, there is evidence to show it is not routinely practiced. (338,346) The Care Quality Commission's national patient surveys show that 48% of inpatients and 30% of primary care patients would have liked more

involvement in decisions about care. (347) In addition to the previously mentioned challenges, studies have found there is a lack of training and familiarity with the concept amongst lung cancer MDT members. (346)

### 5.1.8 Rationale

Decision making, is an under investigated aspect of care and requires further investigation in lung cancer for four main reasons. Firstly, the majority of the literature on decision making in oncology is based on all cancer patients or patients with gynaecological/breast cancer where management decisions are heavily guideline driven. In comparison, lung cancer is shown to involve an older, more complex population where the optimal strategy may not be as directive.

Secondly, studies that have investigated decision making in lung cancer have concentrated on one portion of the patient pathway such as the MDT meeting. Few have investigated the effectiveness of the whole decision-making process. For example, if the recommendation made in the MDT meeting was subsequently discussed with the patient and implemented. With a cost of approximately £87.41 per case discussion, it is essential that the whole process is proven to improve outcomes for patients. (348) Section 2.4 highlights the difficulties of randomised controlled trials in demonstrating such benefits. Consequently, other research methods should be adopted to holistically assess decision making in the MDT.

Thirdly, variability in patient decision making between units has been demonstrated illustrated by studies citing refusal rates for curative intent lung cancer treatment between 20 and 32%. (92,186) The factors contributing to this variation remain under investigated

Finally, research on SDM has focused on the creation of decision support tools rather than understanding the attitudes and behaviours of the health care professionals who are in a

position to deliver this model of care. To gain a wider understanding of decision making it is not only necessary to identify the factors that influence decision making, but it is also important to uncover attitudes to SDM in the lung cancer community. Legare et al found that the most significant variable determining whether a patient will engage in SDM is the physicians' attitude to SDM. (349)

# 5.2 Methods

## 5.2.1 Aim

The aim of this study is to critically examine the process of local decision making and influence on patient outcomes in one hospital trust in order to develop an implementation strategy to improve the effectiveness of decision making within this MDT.

## 5.2.2 Justification of qualitative methods

A qualitative methodology has been chosen to address the above aim. There is evidence to demonstrate that qualitative research methods are valuable in investigating health service organisation and consequently enable changes in policy for four main reasons. (350)

Firstly, qualitative data has been shown to be key in understating and uncovering meaning behind complex behaviours such as decision making. (351) This is particularly useful when the decision-making process involves team-based interactions such as an MDT meeting. (351) It is accepted that the motivations behind individual behaviours and interactions are complex.

Secondly, it has been established in section 5.1.8 that data on decision-making in lung cancer is lacking. Qualitative research generates novel knowledge through a rich understanding of clinical decision making in its natural context. (351) This is key to giving meaning to views and has the potential to form the basis of change.

Thirdly, change is facilitated by collecting data, identifying areas of improvements and developing potential solutions simultaneously. This type of research is termed action research. (352) Incorporation of fundamental elements of action research has been shown to be a successful method for quality improvement; thus, addressing this studies' objectives. (353)

These elements include that participants define contexts for change and therefore changes are more likely to be implemented and sustained. In addition, the researcher works with the participants' in a democratic manner to instigate change. This is particularly important in a health care setting where traditional hierarchical systems prevail. Participants that may not be involved with formal organisational change in an institution can 'have a voice'

Finally, the qualitative study process itself can be an educational tool for the healthcare team which is key to instigating organisational change. (354) It has been shown that the process of data collection through interviews and observations uncover unacknowledged attitudes that can lead to behaviour change. (352)

### 5.2.3 Setting and Context

The lung cancer MDT from the Heartlands, Good Hope and Solihull (HGS) sites of University Hospitals Birmingham was the subject of this study. The combined hospital sites are one of the largest acute hospital trusts in the country. It serves an ethnically diverse population of 1.2 million across east and north Birmingham, Solihull, Sutton Coldfield and South Staffordshire (355), and in lung cancer also acts as the regional thoracic surgery centre receiving patients in a radius of approximately 50 miles. In 2016/17 the sites saw approximately 267,793 Emergency Department (ED) attendances and 856,556 outpatient attendances with a workforce of 10,565 staff. (355) The lung cancer MDT deals with approximately 1560 patients per year. The majority of lung cancer diagnostic and treatment modalities are provided within the three sites, including thoracic surgery and medical oncology services. Radiotherapy and PET imaging services are provided by the newly merged (in 2018) Queen Elizabeth Hospital site.

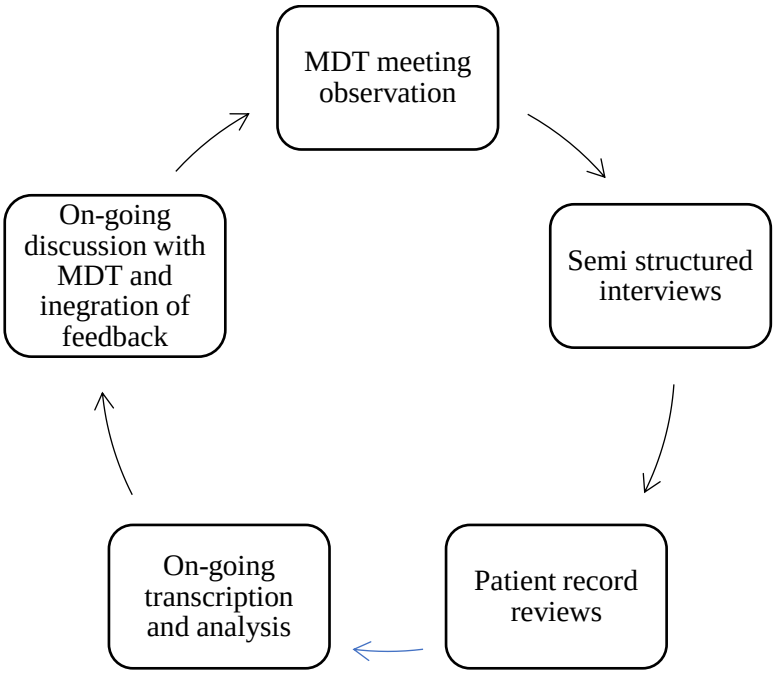
The rationale for choosing this site for the study originated from the results of a local study investigating the barriers to curative intent treatment in early stage Non-Small Cell Lung Cancer (NSCLC) in patients with a good performance status. (309) NHS Improvement highlighted a local resection rate of 15.8% compared to a national average of 17.5%. (356) Therefore, the case notes of all such patients discussed at the lung MDT meeting in 2015 and did not undergo surgery were examined. The commonest reason for patients not to undergo curative intent treatment was recorded as 'patient preference' (44.4%) and none of these patients saw a surgeon or oncologist. The detail behind the decision making was unclear. Consequently, it is vital there is a better understanding of decision making within this MDT to improve outcomes for patients.

The study of one MDT was undertaken to allow in depth study of service provision. The results do not aim to be generalised on a national scale, although if generalizable messages emerge, they might be the subject of future work via the NLCA. I anticipate that aspects of this MDT's decision-making process will provide common links to other lung cancer MDT's. Previous qualitative studies have demonstrated this concept successfully. (354)

### 5.2.4 Participants and data collection

Three methods of data collection were chosen to capture the complexity and longitudinal aspect of the decision-making process. These were semi structured interviews with lung cancer MDT members, MDT meeting observations and electronic record documentation review. A study flow diagram (Figure 5.3) illustrates the data collection process.

**Figure 5.3 Study flow diagram**




Using several data sources and methods enables triangulation of findings and with the aim of providing a richer understanding of the decision-making process. (357,358) Triangulation is a process where a topic is examined with multiple methods or data sources to determine the degree of convergence across the components. (359)

To ensure the MDT was engaged in the research project, JBA met with the lung cancer lead physician and MDT team on several occasions to explain proposed methods, emerging results and improvement strategies. Feedback from the team contributed to the iterative process.

This study focuses on health care professional behaviour rather than that of the patient. Previous studies have looked at the patient perspective and as reported in section 5.1.5 there is evidence to support the assertion that patients want to be involved in decision making. (335) In addition, such studies have reported two main challenges when investigating a patients'

perception of SDM. Firstly, responses tend to reflect a patients' satisfaction with the chosen treatment rather than the decision-making process itself. Secondly, a patient is not able to know if they were provided with all the options. Therefore, to address the gap in knowledge within the remit of this study, the focus was on health professionals' actions and attitudes.

5.2.4.1 Semi structured Interviews

Interviews are considered the most appropriate method for exploring health professional decision making because they capture a real life understanding of individuals' attitudes and actions. (358) This provides additional insights over observation by exploring the subject from the participant's point of view rather than the assumptions of the researcher. (359)

The format of an interview can be unstructured, semi structured or structured. A semi-structured approach was used for four reasons. Firstly, it allows the flexibility to explore new ideas that may not have been considered by the researcher. Additionally, the use of probes, prompts respondents to clarify the meaning of what has been discussed. Rich detail can be gained by this participant led approach. (358) Secondly, non-visual cues are obtained facilitating the modification of the line of questioning accordingly. (354) Additionally, it has been shown that the rapport gained between the researcher and participant creates an environment where more truthful responses are elicited, and fears of social desirability are minimised. (358) Finally, health care professionals have several competing demands on their time and this method has been shown to be useful in gaining access to such groups that are unlikely to respond to surveys. (354)

A purposive sample of MDT members was obtained by face to face contact or email invitation by the research team. Purposive sampling is defined as selective sampling based on characteristics of a population and the objective of the study. (351) The invitation to

participate was open to all members of the MDT via email. However, individuals were targeted to obtain a range of professional disciplines to be approached that have lung cancer decision-making experience. Sample size was informed by the principle of thematic saturation. (360) This is where a point is reached where "no new concepts emerge from the review of successive data from a sample that is diverse in pertinent characteristics and experiences". (358)

A topic guide (A5.1) was developed which explored participants' views, attitudes and experiences of decision making in this MDT and SDM in their practice. It also sought views on improving the current organisation of services. This guide was piloted on two members of staff to ensure that the questions and probes were easily understood. As part of the iterative process the topic guide was modified according to evolving themes and professional role of the interviewee. Subsequent versions of the guide are also included in the appendix (A5).

The interviews took place in participants' offices, clinic or meeting rooms and lasted 10-30 minutes. They were conducted by JBA (primary researcher) and SK. SK is a clinical psychologist who has expertise in qualitative methods and health behaviours. JBA is a respiratory registrar and previously worked as part of the lung cancer MDT with training in qualitative methods and research interview technique. SK interviewed members of the MDT whom JBA has directly worked with in order to minimise bias.

5.2.4.2 MDT meeting observations

Observation and recording of the MDT was chosen to capture detailed data about the behaviours of health care professionals in their natural setting. Previous work demonstrates that this is a valuable method of exploring decision-making in a healthcare setting and thus

explain variations in patient outcomes. (361) Additionally, self-reported behaviour can introduce social desirability and recall bias. (351)

MDT members were notified that a succession of meetings would be recorded via email and in person at the beginning of the recorded meetings. The study was presented as an investigation into decision making in lung cancer. The lack of detail given in the initial information was intended to prevent a change in behaviour of the participants based on the detailed aims of the project. This is called the 'Hawthorn effect' (351). The whole meeting was audio taped and field notes were written immediately after the meeting including details about the meeting attendance, chairing, team working, infrastructure (venue, seating and equipment) and meeting organisation. In addition, non-verbal information was recorded including personal reactions to the events. This is a recognised technique in observational, ethnographic research, and such notes frequently form the basis of initial hypotheses. (351) The MDT meeting observations occurred in parallel with the series of interviews and contributed to the iterative modification of the interview topic guide.

JBA conducted all the meeting observations. As a previous participatory member of this MDT meeting, her presence was not anticipated to be an intrusion. Observations were conducted until thematic saturation was reached.

5.2.4.3 Document review

Written documents can be a valuable source of data particularly when studying the outcomes of patients. Therefore, a review of electronic case notes and MDT meeting outcome documents was conducted to document demographic, diagnostic, management and MDT outcome information.

## 5.2.5 Data Analysis

### 5.2.5.1 Transcription

Interviews and MDT meetings were audio-taped and transcribed verbatim. This method of recording data is recommended because allows the interviewer to be more responsive during the observation process. Additionally, taping ensured accuracy of the data which can be verified by another researcher if necessary. Finally, an in-depth analysis of the data can be conducted of the transcribed content. (362)

All the MDT meeting and six interview recordings were transcribed verbatim by the JBA as per standardised rules of transcription. (354) An external transcription service was used for the remaining interviews in accordance to the same rules. All transcripts were checked alongside the recordings by JBA to ensure consistency of transcription and amend errors. In addition, this allowed the researcher to familiarise with the data to aid the process of data analysis. Importantly, all patient, health care professional and site identifiers were removed to ensure participant confidentiality.

### 5.2.5.2 Computer assisted qualitative data analysis (CAQDAS)

The use of CAQDAS has been shown to be an accurate method of managing, storing and coding qualitative data. (363) Therefore, after the transcribed material in Microsoft Word was stored and managed in a specialist software programme (NVivo-7).

### 5.2.5.3 Thematic Analysis

#### *5.2.5.3.1 Choice of Method*

The approach used to analyse the data set was thematic analysis. This is a method of "identifying, analysing, organising and reporting patterns (themes) within a data set". (364) Themes are recurrent unifying concepts about the subject. (358) Meaning is attached to themes in the development of theory.

Thematic analysis was chosen for two main reasons. Firstly, the aims of study will lead to differing categories of results. The exploration of attitudes, and experiences leads to descriptive results, whereas identifying areas of quality improvement leads to more factually based information. Thematic analysis is suited to addressing these differing results because it is not tied to a particular theory such as grounded theory, ethnography or phenomenology. (364) Consequently, this flexibility is advantageous to health service studies. (352,364) Secondly, there are published methodology guidelines. (364) This increases the rigour and reliability of the analytic process.

A commonly used qualitative analytical approach within the umbrella of thematic analysis is the framework method. (365) This method identifies relationships between sections of the data. (365) The output is usually formatted in a matrix. where data is organised into rows (cases), columns (codes) and 'cells' of summarised data. The advantages of this method relevant to the aims of this study include the following. (365):

1. Several data sources can be systematically examined and analysed at the same time.
2. Interpretation of experiences and attitudes of participants are transparent through illustrative quotes increasing the rigour of the analysis. (365)
3. A case and theme-based approach can be applied to interpreting the MDT meeting and documents review data. (365)

4. A combined inductive and deductive approach can be applied. (365) The aims stipulate the investigation of specific issues. However, this method also allows unexpected aspects of experience to be uncovered.

*5.2.5.3.2 Applying a thematic framework approach*

The stages of analysis are illustrated in Table 5.4.

**Table 5.4 Stages of thematic analysis**

| **Step** | **Description** |
|---|---|
| 1. Data management | The data was transcribed, checked for accuracy and re read. Initial ideas were generated, and notes made on these impressions. |
| 2. Coding | Interesting features of the data were categorised into codes by considering each line or paragraph of the transcript by the primary researcher using NVivo. |
| 3. Developing an analytical framework. | Codes were grouped together to form categories, and this formed a working framework. This was developed from one MDT meeting transcript and four interview transcripts till no additional codes emerged. The framework and sections of the transcripts were continuously discussed and reviewed with a second researcher. Refinement of the framework occurred simultaneously and throughout the process. |
| 4. Applying the analytical framework | The framework was applied to the subsequent transcripts using the existing categories and codes. |
| 5. Charting data into the matrix | Data was charted into a matrix and included references and illustrative quotes. |
| 6. Interpreting the data | Impressions and initial interpretations were recorded via analytic memos. Characteristics, relationships and differences were explored alongside the identification of areas for quality improvement. |

5.2.5.4 Formulation and implementation of an improvement strategy.

Throughout the above process, the findings were fed back to the participants for validation and discussion about an improvement strategy occurred. The resulting strategy was derived from the main results of the study and modified according to the responses of the participants.

### 5.2.6 Ethics

The protocol and study were reviewed and approved by the 'Research and Development' department of the HGS sites and 'Information Governance' team as being consistent with delivering a quality improvement project. Participation in the study was on the basis of informed consent and study was carried out in compliance with the Helsinki Declaration. Participation was voluntary. MDT members were made aware of the occurrence of the MDT observations and recording via email and prior to the start of the meeting. Participants were given time to raise objections or ask questions. Anonymity was ensured throughout the study.

# 5.3 Results

## 5.3.1 Data Sources

### 5.3.1.1 Interviews

Twenty-three members of the MDT were invited for interviews via email or in person. 13 interviews were conducted before thematic saturation was reached. All but one healthcare professional agreed to the initial invitation. The professional roles include lung clinical nurse specialist (LCNS) (x2), MDT co-ordinator (x2), lung cancer service lead (also respiratory physician), thoracic surgeon (x2), thoracic histo-pathologist (x2), clinical oncologist (x2), clinical cancer service nurse lead (previous lung CNS) and respiratory physician.

### 5.3.1.2 Documentation review

For each patient discussed in the MDT meeting, the correspondence, investigation results and MDT outcome documents were reviewed. Details of eighty patients were recorded. A summary of the patient demographics is shown in Table 5.5.

**Table 5.5 Patient demographics of the discussed patients**

| | | **N** | **%** |
|---|---|---|---|
| **Age (years) (n=80)** | **Median** | 70 | (Range: 27-90) |
| **Sex (n=80)** | **Male** | 43 | 54 |
| | **Female** | 37 | 46 |
| **Stage (n=50)** | **I** | 12 | 24 |
| | **II** | 7 | 14 |
| | **III** | 15 | 30 |
| | **IV** | 16 | 32 |

5.3.1.3 MDT meeting observations

Three meetings were recorded in May and June 2018 before saturation point was reached. Table 5.6 illustrates the attendees' professional roles and a description of their responsibilities and contribution in the MDT meeting.

**Table 5.6 Attendees at the lung cancer MDT meetings**

| **Professional Role** | **Role/responsibilities/contribution to MDT meeting** | **Number present in the meeting on average*** |
|---|---|---|
| Respiratory physician | -Co-ordinates the lung cancer pathway<br>- Presents the majority of patient cases<br>- Needs to collate patient and investigation information | X4 consultants and x1 SPR |
| Lung cancer medical oncologist | -Contributes specialist knowledge in providing chemotherapy to lung cancer patients | X2 consultants and x1 SPR |
| Lung cancer clinical oncologist | -Contributes specialist knowledge in providing chemotherapy and radiotherapy to lung cancer patients | X1 consultant |
| Thoracic Surgeon | -A surgeon who has performed at least one lung cancer resection in the last 12 months<br>-Contributes specialist knowledge on potential surgical interventions for lung cancer patients | X2 consultants and x1 SPR |
| Lung cancer clinical nurse specialist (LCNS) | -A nurse specialising in the care of people diagnosed with lung cancer (and mesothelioma)<br>-Presents patients cases<br>-Contributes patient specific information<br>-Involved in co-ordinating the patient pathway and ensuring continuity of care and communication with the patient | X3 |
| MDT co-ordinator | -Facilitates co-ordinating the patient pathway<br>-Responsible for organising, running and documenting the meeting<br>-MDT outcomes are recorded at the time of the meeting and projected on a small screen at the front of the room | X1 |
| Thoracic radiologist | -Contributes specialist knowledge on thoracic imaging<br>-Determines the stage of cancer | X1 |
| Thoracic histo-pathologist | -Contributes specialist knowledge on diagnostic samples<br>-Determines the type of cancer | X1 |

*based on an average over 10 MDTs in the time period of the observations

### 5.3.2 MDT format and context

The principal activities that occurred in the observed MDTs were information gathering and sharing as well as decision making. Decision making involved seeking opinions, debating options and seeking approval for previously made decisions. The atmosphere was cooperative and there were several instances of banter or joking during the meeting to keep the atmosphere light. Apart from discussions about patients, other interactions included sharing frustrations with access to resources or local team working networks:

*"….they have had no involvement with me..they have..I don't know why they are dealing with…they don't speak to me about my patients. They don't therefore decide what to do with my patients. If I wish my patients to be considered by another clinician, I will refer to them…."*

(Talking about frustrations with links with a local specialist MDT)

(Male, Surgeon)

Colleagues listened to each other and asked for opinions and clarifications illustrated in the following excerpt. Several members are debating the optimal management strategy for a patient and consider other professional viewpoints:

| | |
|---|---|
| *Surgeon1:* | *"Could we not be radical with this?"* |
| *Surgeon2:* | *"Not surgery..I was thinking ..maybe…I mean..what do you think"* |
| *Surgeon3:* | *"there is something..very close to that…"* |
| *Physician:* | *"we cant do neoadjuvant without tissue….."* |
| *Surgeon1:* | *"What (radiologist's name) saying it is tracking along the mediastinum, isn't it?"* |
| *Radiologist:* | *"So yeah..biopsy…mediastinum.."* |
| *Surgeon1:* | *"I would be very wary about a neoadjuvant followed by a left pneumo…is anybody giving concurrent..chemo and .."* |

*Oncologist1:* *"not preop..its not standard..I mean in the States they do neoadjuvant followed by surgery…in Europe we tend to do surgery followed by adjuvant..its doesn't decide in any individual case what you should and shouldn't do but uhmm I think the bottom line from your of view is do you think he is going to be operable? …or what do you say?"*

*Surgeon1:* *"Well I mean..well its always..your right (name of oncologist1) is it operable? Well I mean no. Its not..no we would get positive margins at that…"*

(Excerpt from MDT 2)

The meeting lasted between two to three hours and took place in the education centre of one of the trust sites. The room layout and ground rules has been re-established in the last six months. These standards (Box 1) are emailed to the participants with the list of patients scheduled for discussion each week. Clinicians list patients to be discussed on an online system where a proforma with patient details are completed. The MDT co-ordinator will email a provisional list to the MDT members and ask them to check that all patients still require discussing.

**Box 1: MDT Standards**

1. Strict starting time at 2pm to allow an early finish
2. MDT table layout: with experimentation over recent months, a "U" shaped arrangement of tables seems to bring closer all MDT members and minimises the chance for side talks and makes sound quality better. So please refrain from sitting at the back or separately.
3. Patients with an empty proforma will not be discussed (please complete all relevant information)
4. Patients without a responsible clinician or lung CNS to present will not be discussed (so please nominate another person to present your cases if you are not able to).
5. If it is the responsibility of the referring clinician to make sure all information required is complete before the MDT date to enable a decision on either surgical or oncological treatment. This includes lung function, or any test required to assess fitness. (please refer to the attached surgical referral criteria which should be adhered to internally as much as externally).
6. MDT time is to be used for MDT only and not admin work. Please refrain from completing your admin work or using your laptop during the MDT which often is a distraction to the clinician from the ongoing conversation about the patient in question.
7. For complex patients that attract a detailed discussion at the MDT: It is the responsibility of the clinician offering the treatment plan to make sure the MDT outcome matched their standards and reflects the discussion that took place.
8. Referrals from outside the MDT quorum members will not be discussed and such patients either seen first or discussed at the radiology meeting (LIM/LID).

The format of the meeting follows a standard protocol. Firstly, the chair opens the meeting and swiftly moves on to the first patient. Each patient is then presented by a member of the MDT. The presenter presents information in the form of a summary which may include their clinical presentation, past medical history, functional status, treatment plans, diagnosis if already known and the reason the patient is brought to the meeting. A radiologist then presents the radiographic findings and then the pathology is commented on by the histopathologist. The radiology images and pathological slides are projected for all members to view. A discussion regarding the next step will then ensue which in the main involves the surgeons, oncologists and respiratory physicians at consultant level. Nurses sometimes commented but only usually if they were asked a question. It was rare for junior medical staff to participate in the discussion unless asked a direct question. Once the discussion ends, the outcome is sometimes dictated to the co-ordinator who writes this down and the chair moves

to the next patient. On occasion the wording of the outcome will be verified with the rest of the MDT. At the end of the meeting there are usually a few patients that are discussed who are not on the list which go through the same format.

### 5.3.3 Themes emerging from the data

Participants described, and the researchers observed, that decision making in lung cancer was complex:

*"…lung patients in general have multiple investigations as well. So the pathway is quite complex. Well I've noticed well it's a site that I haven't done before, so it's quite complex really. They come for multiple investigations, so it's keeping a track of all that as well, isn't it?"*
(MDT co-ordinator, female)

The patient journey involved several health care professionals, multiple investigations and decisions were made at several points. Oversight of this journey by a single responsible professional led to efficient decision making, improved shared decision making and outcomes for the patient. The knowledge, attitudes and skills of the MDT members were additionally key to influencing this process.

Therefore, three main themes emerged from the data with several subthemes. This is summarised in Table 5.7 and Table 5.8 details how the themes were derived with example quotes.

**Table 5.7 Conceptual framework summarising the main themes and sub themes**

| **Main Themes** | **Sub-themes** |
|---|---|
| 1. Continuity of care | a.) Ownership of the patient journey<br>b.) Barriers to effective information flow<br>c.) Facilitators to effective information flow |
| 2. Knowledge and Attitudes | a.) Understanding and attitudes to SDM<br>b.) Challenges to implementing SDM |
| 3. Training and Skills | a.) Patient assessment skills<br>b.) Incorporation of guidelines/clinical trials |

**Table 5.8 Transformation of themes: illustration of the analytical procedure**

The procedure used in similar studies was followed (366). Important meaning units were identified, units were transferred into language relevant to the research (transformation I) and then collated into common experiences (transformation II). Finally, common features were transformed into key constituents.

| **THEME 1: CONTINUITY OF CARE** | | | |
|---|---|---|---|
| **Ownership of the patient journey** | | | |
| **Meaning unit** | **Transformation I** | **Transformation II** | **Key constituents** |
| In response to questions about improving the effectiveness of decision making:<br><br>*"A dedicated lung cancer physician would then probably have a much better oversight of what was happening and be able to carve slots out for this and that as their dedicated work, triage what's coming through, two weeks waits, what's going to MDT, what needs to be followed up from MDT. So I would say that a dedicated consultant is what is needed."* (LCNS, female) | The participant states that a dedicated lung cancer physician is required to ensure that there is oversight over the whole patient pathway. | A dedicated physician is needed to ensure there is continuity of care for the patient. | An important aspect of improving decision making is ensuring a dedicated professional is responsible for the whole patient pathway. |
| **Barriers to effective information flow** | | | |
| *"…but sometimes I feel especially when enough information is not available MDT members can be more pessimistic than what they should be and hence some patients may* | Participant stating that insufficient information presented at the MDT meeting can affect treatment options offered | Insufficient patient information presented at the MDT meeting can impact on patient outcomes. | Missing and inaccurate information impacts patient outcomes |

| | | | |
|---|---|---|---|
| *not be offered treatment ….”*<br><br>(Physician, male) | to the patient.. | | |
| **Facilitators to effective information flow** | | | |
| In discussing the optimal management of a patient:<br><br>*Surgeon1: “..essentially if this is an endometrial met then I don’t think we should do anything about it”*<br><br>*Lead: “There is no need for metastectomy for this cancer?”*<br><br>*Surgeon1: “Well no she is known to have recurrence ..”*<br><br>*Clinical oncologist:” No but if she has had controlled primary disease for 6 months she can have SABR to that as part of CTU..commissioned through re-evaluation.”*<br><br>Excerpt from MDT 3 | Clinicians are discussing the optimal management of a patient in the MDT meeting. The initial proposal of not treating the lesion is challenged and other options are proposed including surgery and radiotherapy. In this case, all options were discussed with the patient and the discussion did not require further input at a MDT meeting. | Opinions are challenged in the MDT. This leads to the exploration of further options for the patient which means that the case is less likely to require re-discussion. | Debate and challenging of ideas facilitate effective decision making. |
| **THEME 2: KNOWLEDGE AND ATTITUDES** | | | |
| **Understanding and attitudes to SDM** | | | |
| *“…But I have a very strong belief that I should not be pushing a patient enforcing a patient into a decision I should be* | Participant expresses the opinion that if possible, clinicians should help | Members feel that the preferred model of decision-making is where the health | Some participants have a positive attitude to SDM. |

| | | | |
|---|---|---|---|
| *facilitating the patient make a decision where possible."(*Surgeon, male) | patients make decisions. | care professional helps the patient make the decision. | |
| **Challenges to implementing SDM** | | | |
| *"There is a small number of patients who just do not wish to make a decision and there are occasions where you have to decide on their behalf"*<br><br>(Physician, female) | The participant describes that there are circumstances that patients express a wish not to engage in decision making. | A challenge of implementing shared decision making is reluctance of patients to engage with the decision-making process. | Patients' wish as a barrier to implementing SDM. |
| **THEME 3: TRAINING AND SKILLS** | | | |
| **Patient assessment skills** | | | |
| *"I think a lot of people could do with additional training in performance status."*<br><br>(Oncologist, male) | Participant feels training in performance status is required. | There is a need for training in PS assessment amongst members of the MDT. | Training in performance status is required. |
| **Incorporation of guidelines and clinical trials** | | | |
| During a discussion of a patient with a ground glass nodule:<br><br>***"t****hat if we noticed there is no solid component.. then the guidance is not to PET them and not to take them out."*(Excerpt from MDT 2) | In this MDT meeting discussion, guidance in the management of ground glass nodules is referred to. In this case, the guidance was adhered to and the patient did not require further discussion. | The reporting of guidelines in MDT discussion facilitate implementation of the documented outcome and avoidance of re-discussions. | The incorporation of guidelines into MDT discussion facilitates successful decision making. |

#### 5.3.3.1 Theme 1 Continuity of care

##### *5.3.3.1.1 Ownership of the patient journey*

Interviewees talked about successful decision making in terms of decisions not being brought back for multiple re-discussions. An important aspect of this process was "ownership" or "responsibility" over an individual patient. This was reflected in the observations and interviews.

There were some differences in opinion as to who should be responsible for oversight of the pathway. Some felt that it should be a dedicated person/s:

*"I think probably the best person to do this, so you are talking about every single patient in the entire system, so it is either going to be the MDT lead or plus/minus or in conjunction with one of the senior nurses I suspect would probably be the best combination."*

(Female, physician)

Whereas another participant felt it should be the clinician who referred the patient to the MDT. When asked about who they felt should have oversight of the patients' pathway, this participant responded:

*"...the person who referred the patient. .....but you know the person who referred the patient they should organise that investigations. It relies on them, if you organise the investigation you need to follow-up and act on it so its their responsibility, you brought this patient to MDT, we have recommended this investigation and if its this result they go there and if not and its your responsibility to refer."*

(Male, oncologist)

The lack of consensus over who should have responsibility for a patient was additionally observed. In 35% of the MDT case discussions (28/80), it was unclear if the presenter had previously met the patient. This demonstrates confusion over who should oversee the process of seeing a patient, listing them on the MDT, presenting them and then following up the actions. This participant describes how the lack of participation in decision making by a responsible professional occurs frequently within this MDT leading to multiple unnecessary re-discussions.

"*…but then as the person who is looking after the patient isn't there we frequently get just a case presented and everybody is having a discussion but the person then needs to go back and discuss it with the patient who isn't there. To me that doesn't make any sense at all. At the end of the day if the person who looking after the patient is not in the room that case discussion is completely redundant and we simply should not discuss it…..We always have one or two who are not there, we have patients listed, for example this last MDT and some of the surgeons of the patients on that were not there and that is about four or five cases and we end up having discussions and saying we think this is what the clinician thinks about it and we end up having a discussion when we are not 100% sure and I guarantee those cases will come back on the list when that consultant comes back from holiday or is able to attend the meeting where we will discuss those cases and wasted MDT time and not achieved anything in terms of the patient"*

(Male, Radiologist)

The observed consequences were that in 29% of cases the documented outcome did not get implemented and in 25% the case was brought back to the meeting for re-discussions leading to delays in treatment.

The following example from MDT 3 is an excerpt from a discussion of a patient that was seen in clinic by a junior doctor and illustrates this issue. The named consultant of the patient is presenting the case:

"*He is a 74 year old man who had a small ground glass abnormality at the top of his left lung last year. We uhm ahem have been following it looks like its was beginning to grow. Uh he has subsequently had a PET scan we are here to discuss the possibility of him having it removed.* "

(MDT 3)

There is subsequent documentation reporting the patient has several co-morbidities including dementia and the patient and family did not want further investigation. The lack of continuity of care meant that vital information about the patient's preference was not shared. This led to un-necessary investigations and inappropriate multiple MDT discussions.

In addition, missing and inaccurate information presented in the MDT was shown to impact patient outcomes. It is unclear in the following excerpt whether the presenter has met the patient. They are discussing a patient that had previously been discussed at MDT with a plan for neo-adjuvant chemotherapy.

"*67 year old guy uhmm initially we spoke about it earlier this year with a possible neoplastic lesion in the left apex and he had a biopsy of that went then ahem onto oncology for neoadjuvant treatment and we're hmm basically looking to how he got on after that and where we go from here. "*

(MDT 2)

After further discussion it is evident that this patient had not actually received chemotherapy. On documentation review this was the third MDT discussion for this patient. On the first occasion the PET scan results were not available then subsequently the CT guided biopsy had not been performed. Due to the lack of continuity of care and accurate presented information a referral to oncology was not made until six weeks after the initial MDT recommendation. The consequence of this meant that significant delays to oncology assessment led to tumour progression and change of management from curative intent to palliative intent treatment.

This was apparently not an isolated scenario as demonstrated by the following quote:

"*I mean there have been a few cases actually where it was uncertain it was uncertain of the diagnosis and then they were presented many times .....treatment was delayed that I mean they were surgical when we first discussed and then after about 5 discussions they were not and then I was called by (surgeon name) clinic saying that she got basically got cord compression and then it all becomes palliative. I mean if we had acted, I mean essentially she was surgical if we had acted upon I mean if its surgical its surgical. If we have a tissue diagnosis of cancer then you can operate. So in that particular case she now become palliative and ....."*

(Male, oncologist)

This is supported by the finding that there was incomplete or inaccurate information presented in 39% (31/80) discussions. Out of those 31, 22 patients (71%) were for potentially curative intent treatment and experienced pathway delays. The consequences of which were that 7 of these 22 patients (32%) had a documented decline in performance status or a management plan change from curative to palliative intent treatment.

In contrast, there were cases where clear ownership of the patient pathway was demonstrated:

*"This is a 85 year old gentleman with several co-morbidities including arthritis, TIA's, previous ablation for tachycardia, palpitations and ....he is doing quite well for himself up until recently till his wife who he is the main carer and has got dementia, bedbound. Since then his mobility has gone down as he is bedbound..not bedbound has been housebound looking after her. Urmmm he…we had a good chat…he got good lung function etc…we had a good chat..didn't really think that invasive therapy was going to be the way forward. His main problem was back pain so we have referred to (clinical oncologist's name) who is kindly going to do it"*

(MDT 2)

Examination of clinic documentation revealed that the presenter had a detailed discussion about potential management options with the patient in clinic. This led to a shared decision of being referred for palliative radiotherapy. The patient received an assessment by a clinical oncologist and symptom management within seven days of referral and three days of the MDT meeting. This case exemplifies that knowledge of patient centred information and clinician responsibility for the patient journey has the potential to improve effective and efficient decision making.

*5.3.3.1.2 Barriers to effective information flow*

Accurate information sharing was observed to be a key component of the decision-making process; two barriers were identified.

Firstly, key factors that impact decision making differ between what is perceived and that observed. This is problematic because key information that is considered to be vital to determining a patients' management is evidenced as not being considered in practice.

Observation of the MDT meetings revealed that the information that was consistently presented were the patients age (100% of discussions), stage of tumour (98%) and histopathology if available. Whereas, patient specific information was reported less frequently: that in only 10% of discussions, performance status was presented; 28% co-morbidities and patient views in 6%. Therefore, disease specific information was shown to predominately influence decision making. However, participants stated that they considered patient centred factors to be most important when asked in an interview. These included a patients' performance status, co-morbidities, general well-being and preferences.

The following are examples of responses to the question: “what in your opinion should influence decision making in lung cancer?”

*“Patients performance status Comorbidities. And you know the general overall performance status”*

(Male, LCNS)

*“Well-being the patients Yeah I think that's one of the main factors”*

(Male, Pathologist)

*“…main decision is obviously the stage of the tumour and obviously the performance status. So if the patient is fit and has an early stage cancer”*

(Male, Oncologist)

Several participants describe general well-being as the predominant factor which is not in keeping with what was observed in the MDT.

Secondly, the documented outcome was perceived and observed not to reflect the discussion occurring in the MDT meeting. Observation of the MDT meetings revealed that the documented outcome did not completely reflect the discussion in 54/80 cases (68%). Subsequent review of patient records showed that this was associated with multiple re-discussions and delays to appropriate patient care.

In MDT 2, participants discuss treatment options of a patient with several lung lesions. A full debate included the consideration of several options including immunotherapy, surgery and radiotherapy. The outcome of this complex discussion was recorded as below:

*"MDT outcome: Performance status 0. Right upper lobe lesion measuring 13mm, left upper lobe 11/12mm , both lesions slightly increased in size, continual slow growth since 2009, show no activity on PET scan. Radiologically slow growing leision over 5 years for clinical review to suggest no further action."*

Consequently, a clinician saw the patient in clinic and communicated this outcome and discharged the patient from clinic. In this case the outcome failed to encompass the lack of consensus within the team. Therefore, potential management options were not discussed with the patient and a fully informed decision would not have been made.

Several participants describe experiences where the documented MDT outcome lacks vital information. In light of the previously mentioned issues with continuity of care accurate documentation of discussions is crucial to implementing MDT decisions.

*"the complexity of the MDT discussions are not translated adequately into the MDT outcome recording. This means that the discussion is only as good as the recording of the outcomes."*

(Female, Physician)

"*some of the communicated decisions are odd and I have taken patients back because I just totally disagree with decisions"*

(Male, Surgeon)

The MDT co-ordinators document the meeting outcome in real time. This was acknowledged by several members to be a difficult task and requires more support.

*"….they* (referring to the MDT co-ordinators) *do a difficult job and they do have a lot of responsibilities in that MDT. ……I think the co-ordinators are should be the right people to minute the meeting but I think they could do with more support in what is important in adding to the MDT and whats not…… but I don't always feel like they know whats important I think we could do working closer with the MDT co-ordinators with regards to that"*

(LCNS, female)

*5.3.3.1.3 Facilitators to effective information flow*

Observations highlight that a full discussion where ideas and opinions are challenged and expressed by several members of the MDT leads to effective and efficient decision making. Cases where several members contributed to in-depth discussions were associated with implementation of the MDT outcome and avoidance of re-discussions. Complex patient cases appeared to encourage such debate; therefore, the complexity of the case was not associated with a poor outcome. For example, in MDT 3, participants are considering the next best step for the management of a patient:

(Advocating surgery)

*Oncologist:* *" but I mean..prognosis of thymoma depends on getting it all out..thats the prognostic issue."*

(Challenging surgery and exploring other options):

*Physician:* *"whats the consequence..the diaphragm?"*

*Surgeon:* *"well..uh uh the phrenic..we see lots of ...they compensate well. As she gets older..she might need something. And the question is do we do everything together with a debilitating thoracotomy and sacrifice the phrenic and plicate the diaphragm at the same time. So I..I ..I have to put all of that to her"*

*Radiologist:* *"If you did do surveillance, you would get reasonable images on MRI.."*

*Pathologist:* *"It might be worth another opinion"*

(Excerpt from MDT 3)

In this discussion ideas are challenged, and the voices of several professional groups are heard. Subsequently, an in-depth conversation occurred with the patient with exploration of several management options.

Participants frequently talked about how information articulated by the LCNS was key to quality decision making:

*"….that the clinical specialists act as the patients advocate in that meeting so I would hope that the patient is represented within that meeting. All their thoughts, feelings are represented within that meeting by the clinical nurse specialists, so that their not being falsely represented and decisions are not being made that may not necessarily agree to."*

(Nurse lead for cancer services, female)

The advocacy role of the LCNS is demonstrated in the following case presentation.

*"He is a chap with performance status of 1. Possible asbestos exposure and worked as a carpenter and he is not really keen on having biopsies. I spoken to him the other day and he is just not really keen at all on having biopsies so if there is a possible radiological diagnosis then he is happy with that to be left alone. "*

(LCNS, female)

Patient centred information is presented in this case leading to effective decision making in line with the patients' views.

5.3.3.2 Theme 2 Knowledge and attitudes

*5.3.3.2.1 Understanding and attitudes to SDM*

Understanding of the term 'shared decision making' was variable amongst members. Some interpreted the term to mean decision making within the MDT.

*"....as a collective decision making so everyone sat round discussing patients and different treatment that's there"*

(Male, LCNS)

Others described SDM to be sharing information with the MDT and the patient.

*"One is sharing of information within the MDT and the other sharing with the patient.. It is a two-step process."*

(Female, Physician)

Finally, a patient centred meaning was attached to the term by some members.

*"...its the involvement of patients in terms of what treatment options they have involving patients and saying these are your options and you know if you go down this route this is possible and if you go down this route this is possible"*

(Oncologist, male)

Once a shared understanding of the term was gained, attitudes towards the concept were generally positive. Participants talked about how this is the preferred model of decision making and described experiences where clinicians took steps to ensure that patients drove decision making.

*"Ultimately it is their decision, so they do have to make that choice, and I'm all for promoting patient self-management and actually giving them a voice and some control over what's happening"*

(LCNS, female)

*5.3.3.2.2 Challenges to implementing SDM*

Challenges to the implementation of SDM into routine clinical care were discussed with participants and observed in MDT meetings. Three main challenges emerged from the data.

Firstly, the attitudes of the clinician were seen as a barrier. The participant below describes how they perceive arrogance can inhibit SDM:

*"..I think the clinicians approach to patients has a lot to do with it and this is down to certain personalities of certain clinicians something clinicians who embrace you know in discussions with patients and very much give them all the information and allow them to ask questions and give them all the information to make an informed decision and then there are other clinicians who don't who I feel their arrogance tends to shine through and overrule the discussion and quite often patients can feel railroaded and kept in the dark.."*

(LCNS, male)

Secondly, assumptions made about patients' views or well-being were shown to limit proposed management options. For example, in this MDT discussion the participant makes an assumption that the patient is frail due to their age despite the fact that the presenter who has assessed the patient does not describe the patient has frail.

*Oncologist:* *"Did you say frail?"*

*Surgeon:* *"Well he is ok..more kind of..no..not……"*

*Oncologist:* *"Is he symptomatic?"*

*Surgeon:* *"No , not symptomatic"*

*Oncologist:* *"But hes..frail….we checked his age".*

*Oncologist:* *"But you have not proved it..and you have had a go and its not changed for two years..I think I would leave well alone at the moment..I don't know what everyone else thinks in a frail 84/85 year old."*

(Excerpt from MDT 3)

Based on this expressed opinion of the oncologist, a decision was made for no further investigation or treatment. This finding was reflected in the participant interviews where members reflected on the consequences of assumptions being made about patients in the meeting.

*"Often MDT members they can make assumptions about the patient and what they want but if they haven't met the patient then they can't truly say what's the best approach for a patient."*

(Male, Physician)

Finally, participants stated that, on occasion, patients' present a barrier to engaging with SDM.

*"There is a small number of patients who just do not wish to make a decision and there are occasions where you have to decide on their behalf"*

(Male, Oncologist)

5.3.3.3 Theme 3 Training and Skills

*5.3.3.3.1 Patient assessment skills*

Gaps in training and skills were found to have an important impact on MDT decision making. Inconsistencies in the evaluation and assessment of performance status were identified and this was linked to delayed care demonstrated in the observations and interviews. In the following example the presenter presents the following case from MDT 2:

*"Performance status of 1 or 2….he is 80 and lives in sheltered accommodation. During his first admission he had a scan which was followed by an EBUS and he was readmitted with what sounds like a chest infection."*

(Excerpt from MDT 2)

In this case a performance status of 1 or 2 is not in keeping with the subsequent description. In addition, a review of the patient records documented the premorbid performance status as 3 according to the ECOG performance status (PS) scale. After this MDT discussion the patient was assessed by the oncology team for consideration of chemotherapy and a PS of 3 was documented as this consultation, therefore chemotherapy was deemed to be inappropriate. This case illustrates that discrepancies in the judgement of performance status can lead to inappropriate referrals and a delay in the patient receiving the most appropriate care (in this case best supportive care).

The following quote by one participant when asked about the assessment of performance status within the MDT meeting highlights this issue and the consequences:

*"Very variable I think its very variable some clinicians are quite poor at it. They will say you know say a 80 year old with a performance status of 0. And you know 0 can do a full day's work well there are not many 80 year olds that can do that, there are some obviously, but often they will say in a wheelchair, well that's not PS 0 is it? Its variable across the board even within the same speciality. There is often disagreement about performance status between the CNS's and the clinicians about performance status so often it is just easiest to see them yourself which takes up a slot and it may not be suitable because they do have a poor performance status".*

(Oncologist, male)

The consequences described above describes delays in care for the patient but how this also has an additional impact for other patients due to delays to clinic appointments.

*5.3.3.3.2 Incorporation of guidelines/clinical trials*

The incorporation of guidelines and clinical trials into decision making was linked to effective decision making. In all cases where a guideline or clinical trial was mentioned in the discussion, the outcome was implemented and not re-discussed. An example is shown in the following excerpt from MDT 2. Here the "Lead" talks about using the Herder model which is a validated risk prediction model recommended by guidelines for the investigation and management of pulmonary nodules". (367) The guidelines advocate CT surveillance for a risk of <10%. The discussion of the management of the pulmonary nodule in this scenario follows guideline care.

*Lead:* *"..ok so its 2.5% so the Herder, yeah 2.5....."*
*Surgeon:* *"So thats CT surveillance"*
*Lead* *"So that will be 3 months from baseline".*
(Excerpt from MDT 2)

The importance of participants' knowledge of current evidence in influencing successful decision making is also reported by participants in interviews. When asked about interventions that would help facilitate shared decision making, this interviewee talks about keeping up to date with current guidelines and evidence:

*"....clinicians I mean in reading updating themselves on a constant basis and keeping up to date with things as they change you know make sure that you know they keep these published studies or research around lung cancer."*
(Physician, Male)

# 5.4 Discussion

## 5.4.1 Principal Findings

This study demonstrates that achieving co-ordinated care in lung cancer is key to achieving effective decision making. Crucially, it demonstrates the real-world consequences of poorly co-ordinated service provision. Several of the identified barriers to patient centred and timely clinical care have the potential to be overcome by improvements in the continuity of care. These include the presentation of adequate and accurate patient information at meetings and incorporation of SDM into routine clinical care. The unique examination of detailed MDT transcripts and longitudinal patient outcome data has enabled a deeper understanding of this issue.

In addition, the results identify significant gaps in training and knowledge of MDT members. The following discussion explores such gaps and the impact in providing quality decision making in lung cancer patients in the context of the wider National Health Service (NHS).

Finally, improvements in patient care have the potential to be improved by implementing a quality improvement strategy addressing identified barriers to effective decision making and conducting action research which will be discussed in section 6.2.3.

## 5.4.2 The findings in the context of the existing literature

### 5.4.2.1 Continuity of care

Effective co-ordination of patient care was shown as a key factor associated with improved patient outcome in section 2.3. The systematic review reports the supporting evidence in the general medical literature as well as highlighting the gap in evidence in the lung cancer

literature. As evidenced in the review, there are few lung cancer studies that demonstrate the consequences to the patient or investigate the effects throughout the whole patient journey.

The detailed analysis of verbatim transcripts and linked patient outcome data, in this study, emphasises that good patient pathway management is vital for effective patient centred decision making and avoidance of delays to treatment. This is uniquely demonstrated using the triangulation of qualitative data in this study. It is shown in chapter 2 and 3 that fundamental to achieving this, is the provision of adequate specialist staff. In section 2.1.5.2, it was significant that six out of the eleven of the main review studies that reported improved patient survival were associated with reduced staff workload and increased access to specialist care. The results from the lung cancer literature and chapter 3 further highlight the beneficial effects of adequate staffing. (159,160) Whilst there is contrasting data regarding the association between workload and survival, it has been demonstrated in chapter 3 that access to the items included in the organisational score (of which 5 out of 11 pertain to the provision of adequate staff) is significantly associated with improved patient outcomes (one-year survival, receiving curative intent treatment and treatment within 62 days).

The results of this study show discrepancy exists about which professional group/s should be responsible in ensuring continuity of care. The interviews undertaken show that participants felt that the role should be encompassed by the lung cancer lead, MDT co-ordinator or lung CNS. Currently, it is the responsibility of the patient's named clinician.

Previous bodies have advocated that the respiratory physician is best placed to co-ordinate lung cancer care. (368) They are usually the first point of contact for the patient in secondary care and can be involved from the initial diagnosis and staging through to treatment, restaging and end of life care. In addition, their ability to manage patients' co-morbidities holistically is

crucial given the demographics of lung cancer patients. Finally, respiratory physicians have a pivotal role in acting as a gate keeper to other specialities. However, for a respiratory physician to successfully fulfil the above duties, adequate knowledge and time must be obtained. Currently, there is only one respiratory physician in the UK that has a whole-time position dedicated to the provision of lung cancer services in their hospital unit. The lung cancer service commissioning guidance recommends that one whole time equivalent (WTE) respiratory physician should be provided per 200 diagnoses per year in order to provide an effective lung cancer service; the HGS site has approximately 1 WTE per 500 diagnoses, indicating a shortfall of 1.5 WTE respiratory physicians. The organisational audit shows that 60% of hospital units fulfil this criterion which is likely to be overestimated due to the self-reporting nature of the questionnaire and difficulty accurately estimating workload. The lung cancer 'Diagnostic Assessment Programmes' (DAP's) in the USA staffed by such specialist staff, described in chapter 1 have demonstrated significant reductions in pathway time. (126)

The MDT co-ordinator role has also been acknowledged as being crucial to promoting seamless patient care. (369) The co-ordinator is responsible for preparing and running the meeting as well as providing a link between the lung cancer service and the patient. (344) However, they are not routinely considered in studies assessing the effectiveness of lung cancer decision. This study 'gives voice' to this position and highlights their competing demands and lack of support to fulfil the role effectively. A national survey of MDT co-ordinators conducted in 2012 found that nearly half feel that their opinions are not considered in decision making. (369) Additionally, unmet educational needs were identified in this professional group. These findings are reflected by the results of this study. Furthermore, outcome documentation (a role undertaken by the MDT co-ordinator in the examined hospital trust) was found to not reflect the discussion in the majority of cases. Consequently, all

available options were not discussed with the patient leading to further re-discussions and delays to appropriate patient management. Interviews reveal that the co-ordinators feel inadequately trained to deal with the complexities specific to lung cancer patients. This highlights the unmet educational need of this undervalued group and an under investigated area where potential improvements can be made.

Whilst, the results do demonstrate examples of clear ownership of a patient pathway there are two main challenges to ensuring that this occurs consistently.

Firstly, the comments section of the second organisational audit conducted in chapter three show that few members of the MDT are given dedicated time and resources in job plans for this time-consuming task. This is in keeping with the results from this study that reveals that cases where there was lack of preparation for the meeting led to the presentation of inaccurate or incomplete information and ultimately delays to patient care. Information available at the meeting that was key to the successful implementation of the documented outcome and avoidance of multiple re-discussions were the patient's performance status, co-morbidities and views. Presented in 10%, 28% and 8% of cases respectively. Moreover, out of the 31 patients that were for potentially curative intent treatment, 22 had incomplete information presented at the meeting. Seven of whom had a decline in performance status or a treatment change from curative intent to palliative as a consequence. This finding is corroborated by participants experiences described in the results. These findings are in keeping with other MDT observational studies where Lamb et al found in their study that only 4% of MDT meeting discussions involved patients' holistic information directly in the decision-making process(370). In two other studies that evaluated treatment decisions in MDT meetings, decisions that account for preferences, performance status and co-morbidities were more likely to be implemented. (371,372) This is considered important by MDT members as

evidenced by the interview responses in this study. A systematic approach to include such information through the use of structured proformas has been advocated in previous work to improve decision making. (339)

Secondly, successful co-ordination of the pathway requires specialist knowledge of national pathways/targets, relevant guidelines and clinical trials; a theme that was identified. The fact that guideline adherence in lung cancer has been shown to be only 44-50% in population studies demonstrates that dedicated time for educational activities is additionally required. (373)

5.4.2.2 MDT meeting effectiveness and shared decision making

Implementation of the documented MDT meeting outcome has been used as marker of MDT effectiveness by other studies. (371,372) Half of documented decision outcomes were found to be implemented. In cases of non-implementation, patients were more likely to be brought back to the MDT meeting for re-discussion leading to delays in patient care. Blazeby et al reported that 15% of documented decisions were not implemented when evaluating 273 upper gastrointestinal MDT cases. (371) Other studies have quoted figures of up to 40%. (371) At present there is little similar lung cancer data published. However, the results are not unexpected given that the performance status of lung cancer patients demonstrate a quicker decline compared to other cancers. (3)

There were four main reasons documented MDT decisions were changed: lack of patient centred information presented, poor participation from all professional groups in case discussions, the previously discussed issue of MDT outcome documentation and inconsistencies in patient assessment.

The most common reason for a change in a decision was due to incomplete or inaccurate information considered at the meeting. This included investigation results as well information about the patients' health status. This finding is in keeping with the results from the study by Blazeby et al and has been discussed above.

Several observational studies have found that the consideration of patients' wishes to be an important factor. 8% of cases considered patients' views as part of decision making in analysis of MDT meeting transcripts. This is in keeping with evidence from studies showing that there is poor integration of patient views into MDT meetings partly attributed to the lack of patient presence. (374) The qualitative methodology of this study enabled the researchers to understand the barriers to incorporation of SDM into routine clinical care. As shown previously, understanding of the term SDM was variable indicating a gap in knowledge. (346) However, in this study SDM was perceived to be an important component of decision making evidenced by the interview responses and similar findings are reported in the literature. (346) However, discrepant data was also identified. Some participants felt that the clinicians' attitude was a barrier to effective SDM leading to assumptions about the patient. This further emphasises the need for MDT member training in SDM.

A facilitator of effective decision making was the participation of several members of the MDT in discussion. Cases where ideas were challenged and opinions were expressed were less likely to be brought back for re-discussions. Interestingly, such debate was observed in the MDT more frequently with complex cases. This has been seen in other MDT observational studies. (375) Furthermore, this is in keeping with current re-evaluation of the MDT process, where a move to only discussing complex cases has been suggested. (232)

Finally, inconsistencies in performance status assessment were identified. This led to inappropriate referrals, wasted clinic appointments and multiple MDT discussions. The ECOG performance status (PS) scale is the most commonly used scale to assess the wellbeing of patients in lung cancer. (306) It is significantly associated with predicting treatment responses and survival. (30) Therefore, decision making is crucially dependent on the accurate estimation of PS. Studies have shown discordance between the PS assigned by oncologists compared to patient reported PS. (304–306,376) However, there is little known about the ability of other MDT members to effectively judge patients' wellbeing. In lung cancer, the initial assessment of PS and hence that presented to the MDT is crucial to determining the patients' treatment. In most cases this is evaluated in the initial two-week wait clinic by a respiratory physician or as an inpatient on a respiratory ward. In both such situations a junior doctor may be the first assessor. In the examined hospital trust it is notable that the majority of new lung cancer patients are first seen by a doctor of registrar level with varying experience in dealing with lung cancer patients. The real-world consequences of this identified gap in skills have been demonstrated in this study. Addressing such gaps is vital for lung cancer patients where the underestimation of PS can expose patients to treatments with toxic side effects and minimal survival benefits. Conversely, the over estimation of PS can exclude patients from potentially curative intent treatments.

### 5.4.3 Strengths and Limitations

The strengths of this study lie in the methodology which address the principles of credibility, dependability and transferability. (359)

Credibility is demonstrated by the interrogation of study findings with the existing literature in the above section. Alternative explanations for results are provided with the provision of

deviant cases. Additionally, the direct portrayal of the participants' experience and observation findings are illustrated in the tables and direct quotes providing evidence to the results.

The iterative nature of the data collection process which was changed in response to the different contexts (e.g. the use of different topic guides as the research developed and according to the professional groups interviewed) demonstrates dependability. In addition, sections of the manuscripts were analysed and discussed with a second researcher. This researcher has an expertise in qualitative research and from a different professional background to the primary researcher. Therefore, valuable insights were introduced. Finally, triangulation of methods allowed self-reporting bias to be minimised.

Four main limitations should be acknowledged. Firstly, only one MDT was examined limiting transferability. The MDT structure of hospitals units vary considerably so the unit in this study may not reflect the structure or expertise of other centres. However, it is anticipated that similar barriers to effective decision making are likely to be identified by other teams (for example the lack of time in job plans for MDT work) and the findings provide useful measures to peer review the effectiveness of other MDTs. Furthermore, steps were taken to increase the validity of the study. Firstly, through the large and diverse area encompassed by the three included hospitals. Secondly, the inclusion of several professional groups added strength to the findings in contrast to the majority of similar studies that focuses on treating clinicians. (369) Finally, MDT meetings and interviews were audiotaped and transcribed verbatim to reduce recall bias. The issue of generalisability is common to qualitative research and is frequently quoted as a strength rather than limitation. The sampling methods do not aim to identify a statistically representative set of respondents and would gain little by being

expanded. (377) In fact it is likely to detract from the detailed information and understanding gained from the data; negating the benefits of qualitative research methodology. (351)

The background of the primary researcher should be acknowledged. JBA is medically trained and works clinically as a respiratory registrar within the examined MDT environment. It is important to consider that the researchers own attitudes and pre-conceptions about the subject may have influenced the direction of the discussion. In addition, the background of the researcher as an interviewer and MDT observer may have influenced responses and decision making. However, the presence of JBA at the meeting was commonplace and therefore was not considered to have had a significant effect on results. Inclusion of SK as an interviewer also reduced the potential for bias.

Finally, selection bias may be introduced by convenience sampling limiting the participants to those that were willing to engage with the research. However, this was addressed by the MDT observations and the fact that over 2/3rds of regular members of the MDT were interviewed.

### 5.4.4 Clinical relevance

Despite the above limitations these results highlight two main issues of wider significance. Firstly, it questions the accuracy of national lung cancer outcome data. Such data included in large datasets is collected from individual hospital trusts. The majority of trusts input information, such as performance status and management plans, as planned in the MDT meeting. The inconsistencies found in PS assessment and proportion of cases where MDT decisions were not implemented found in this study challenges the interpretation of such outcome data and its ability to judge the quality of service provision. It can be argued that these data sets fail to capture vital information such as patient views and the ability of a lung cancer service to implement SDM. There is growing evidence to suggest that this is increasing

important in a condition like lung cancer. Units that may be doing this well can be mis-represented. This study adds to the evidence for the need of patient reported or observational measures to properly assess a service holistically to complement national data findings. (378–383)

Finally, these findings add to those of chapters 2 and 3, that the change that the provision of specialist staff is likely to be an important determinant of lung cancer outcomes. The evidence presented show that staff with specialist lung cancer knowledge and dedicated time, are required to ensure continuity of care and good quality decision making. Without addressing this essential component of service provision, improvements in patient outcomes through the access to novel treatments are unlikely to be accessed.

# CHAPTER 6 DISCUSSION AND FUTURE WORK

## 6.1 Discussion

Lung cancer is the most common cause of cancer death worldwide. (2) Survival in the UK is lower than other comparable countries and national data demonstrates unwarranted variation in outcomes across the country. (214,384) Some of these differences can be explained by the type and severity of cases but gaps remain after accounting for such factors. This thesis presents evidence that inequity in access to essential services exist in the UK and this has a direct impact on lung cancer outcomes.

Evidence presented in the systematic review highlights that co-ordinated access to specialist care is likely to be an important determinant of patient outcomes. In addition, it appears to be a bundle of service factors, rather than one individual factor, that is robustly associated with improved outcomes. The creation of a novel organisational score in chapter 3 explores this hypothesis, demonstrating that patients in England/Wales with NSCLC seen in a trust with a low organisational score are significantly less likely to survive to one year, receive curative intent treatment or receive timely care after adjusting for patient factors. Chapter 5 provides real life evidence of this association. Deteriorations in performance status and progression of tumours are shown in the time it takes for patients' to be diagnosed, staged and receive necessary expertise; shifting the intent of treatment from curative to palliative. This work makes the case for urgent review of investment and structure of our current service model.

In the early 2000's, centralisation and the establishment of targets through national reforms in policy drove change in practice and improved cancer patient outcomes. (384) However nearly two decades on, my work, and previous work by the NLCA , shows that inequalities still

exist. (214) Furthermore, this is on the backdrop of health service reform and efficiency savings, which have almost certainly reduced the funds available for some elements of cancer care. (385) The UK spends less on cancer then other Western European countries and ongoing cuts to key services (such as smoking cessation services) will have a significant impact for people with lung cancer. (384,386)

Centralising care has the potential to provide equity in keeping with published evidence presented in Chapter 1. Specialisation has been shown to lead to lower post op mortality and improved treatment rates in other cancers. (384) However, there are advantages and disadvantages to such service models as discussed in section 2.4.4.

The disparity with international outcomes found for stage III patients and the lack of association with these outcomes with hospital infrastructure suggests that factors other than patient, tumour and organisational variables impact lung cancer outcomes. Clinician preconceptions and nihilistic attitudes at an organisational level may additionally contribute to poor outcomes. This is illustrated in direct quotes in chapter 5 from staff interviews and MDT meeting excerpts in one NHS trust.

Quality improvement strategies have the potential to implement organisational change of attitudes and behaviour through the systematic approach of continuous iterative change. However, embedding change within an organisation such as the NHS is challenging. Barriers found by previous studies are summarised in Table 6.1:

**Table 6.1 Challenges to quality improvement change**

| Issue | Definition | Consequence | Reference |
|---|---|---|---|
| Poor engagement | Important knowledge is not incorporated from key stakeholders e.g. patients | Lack of synergy between different improvement groups | (387–390) |
| Political | Groups block or resist change due to lack of acknowledgement of need for change or consensus on identification of the problem | Disillusionment and inertia | (391,392) |
| Organisational culture | Change not rooted in everyday thinking and practice | Evaporation of change | (393–395) |
| Educational | Staff not adequately trained in implementing and delivering quality improvement. | Lessons and knowledge are lost or forgotten due to high staff turnover | (388,396,397) |
| Emotional | Staff loose interest | Change loses momentum | (387,395,398) |
| Infrastructure | Lack of organisational support | Exhaustion and fade out | (391,392) |

It is therefore unsurprising that the majority of quality improvement projects fail. (399) A systematic review on studies implementing the plan-do-study-act quality improvement method in healthcare found that approximately 80% of identified studies did not fully apply the sequence of iterative cycles. (396) Furthermore, only 15% documented small scale change. (396) The commonest challenge of implementing quality improvement reported by Fitzgerald et al, from their qualitative work examining NHS improvement projects improving early diagnosis of cancer, is resistance of support from important stakeholders due to failure of recognition of the importance of the initiative. (392)

The aim of this thesis is to empower trusts with evidence to campaign locally to align lung cancer services with the national lung cancer optimal pathway. However, there is evidence that organisation wide commitment to quality improvement is required if this is to be successful (including funding support, methodological expertise, buy in and sustained effort).

(400,401) This can be achieved by pressure on organisational bodies to acknowledge the relevance and urgency of change required in lung cancer.

Population based studies, such as the work included in this thesis, have the potential to do this. Example can be taken from the population based EUROCARE studies conducted in the mid-nineties that showed England had lower survival outcomes than comparable countries. (237,275) These findings prompted increased investment in cancer services and governmental policy initiatives resulting in a change in healthcare structure. The data presented in this thesis also has the potential to do the same.

## 6.2 Future work

I have shown that there is a paucity of studies robustly demonstrating the optimal lung cancer service structure to underpin health policy. Only four randomised controlled trials were identified in the systematic review showing the need for prospective, good quality studies. This thesis presents evidence that three main issues require further research: 1.) Regular assessment of UK lung cancer service provision 2.) Further understanding of service factors and outcomes evidenced to impact on patients 3.) Implementing quality improvement strategies at a local multi-disciplinary team (MDT) level.

### 6.2.1 Regular assessment of national lung cancer provision

Regular assessment of the state of lung cancer services in the UK is necessary to determine if improvements are being made and examine trends in resource provision. The organisational audit is currently being repeated using the recommendations shown in Box 1 (section 3.4.4) as a benchmark.

An evaluation of the audit was conducted in November 2018 to identify strategies for improvement. The third organisational audit is planned for June 2019, where lessons learnt from the second audit (summarised in Table 6.2) will be incorporated. Regular quality improvement education and networking events by the National Lung Cancer audit team aim to drive subsequent improvement and overcome the previously mentioned challenges to quality improvement. Additionally, the data is used to underpin NICE guidelines and national targets.

**Table 6.2 Evaluation of the second National Lung Cancer Audit (NLCA) organisational audit**

| Process Item | Issue | Suggested Actions |
|---|---|---|
| **Registration Process** | • Necessity: Aim was the registered lead physician would take overall responsibility for the responses to the audit. 60% response rate, with overall audit response rate of 86%.<br>• No negative feedback from evaluation forms received.<br>• 5 (out of 132) trusts queried who completed the survey. | • Review the necessity of the registration process with the NLCA team.<br>• Send to centre managers and email all other contacts. |
| **Pilot process** | • 2 completed (sent to 6 trusts in total). | • The NLCA team could complete a feedback form prior to approaching the user group. |
| **Audit Process** | • Some contacts were wrong and out of date.<br>• Opportunity for data verification. 97 trusts contacted with 35% response rate.<br>• Participants asked to complete survey at same time as data verification for main audit and over summer | • Create an up to date contact list of all lung cancer leads.<br>• Data verification not required.<br>• Revise timing of audit for the next round |
| **The range of questions and responses covered in the audit** | • Histopathology and palliative care workforce provision should be included.<br>• Some trusts uncomfortable with asking other MDT team members about their job plans.<br>• Difficulty for trusts with more than one MDT to complete with results not being useful for each site. | • Consider including histo-pathologists and palliative care service provision to workforce questions in next round.<br>• Consider targeting MDT's rather than trusts<br>• Collect information on job vacancies (posts funded but no-one in post).<br>• Consider questioning the quality of service provided e.g. many trusts commented that their PET service is slow significantly impeding their pathway |
| **The clarity of wording of the questions** | • The wording of the workforce section was confusing and difficult to calculate.<br>• Required clarification of what constituted lung cancer work.<br>• MDT questions and presentation of results did not accurately portray | • Clear definition of what constitutes lung cancer work included in the 'Help Notes'.<br>• Express in reaching consultants' time as input in sessions per week. |

| | | |
|---|---|---|
| | trusts that have 2 MDT's/ week that combine treatment and diagnostic portions. | • Define how thoracic surgical centres express their time.<br>• Define total workforce figures as number of PA's given to cancer for each person and their PA's per week<br>• Phrase questions as per the commissioning guidance: Do you have respiratory physicians that equate to 10 Pas of direct clinical care per 200 new lung cancer patients? |
| **The length of time needed to gather the relevant information and complete the survey** | • The workforce section was time consuming.<br>• Not too time consuming.<br>• Takes much longer than the 15-20 min stated at the beginning of the survey. | • Revise the workforce section to balance ease of use with accuracy.<br>• State realistic estimation of time to complete. |
| **Clarity and utility of the 'Help Document'** | • Not read and not helpful, particularly for the workforce questions<br>• Mostly helpful | • Help notes should be included in the survey for increased utility rather than a separate document.<br>• Revise workforce 'Help section' to increase clarity. |
| **Response to questions and queries** | • Helpful responses via email<br>• Poor action on email queries<br>• Very prompt<br>• Several email queries and 4x telephone dialogues with team. | • Email agreed action points to participant after email/telephone queries. |
| **Presentation and dissemination of results** | • Presentation ok.<br>• Clear and easy to follow<br>• Well produced report. Useful to benchmark service provision against other trusts<br>• Trusts did not expect that results would be publicly available<br>• Individual workforce results were compared to average from the audit. | • No change to formatting.<br>• Need for an explicit statement at the outset of the next round of the audit of anticipated outputs.<br>• The comparison for workforce results could be the National Commissioning Guidance. |

| | | |
|---|---|---|
| | Those that answered accurately were mis represented. | |
| **Data analysis** | • Raw data sent with clean data leading to confusion- one trust who withdrew their results had data published.<br>• Wrong lines of data used for comparison | • To formulate a standardised method of transferring data between team members to avoid mixing new and old versions of data/reports being disseminated.<br>• Second checker of data/results before being published.<br>• Allow participants to verify data in advance of publication |
| **Negative aspects of organisation of care in additional comments** | • Video conferencing has several technical problems meaning that there is no surgical presence at MDT meetings.<br>• Gaps in staffing being covered by locums resulting in inconsistent care.<br>• Patients not willing to travel distances involved with provision of some services e.g. SABR | |
| **Positive aspects of organisation of care in additional comments** | • Sectorisation of services leading to good representation of specialities at MDT meeting.<br>• Triage clinic keeps MDT numbers low.<br>• Successful implementation of a dedicated nodule meeting.<br>• Good communication with offsite oncology team. Enhanced by electronic chemotherapy prescribing. | |

### 6.2.2 Further understanding of service factors and outcomes evidenced to impact on patients

It is acknowledged that the organisational score is not statistically validated, hence further work is required to test the reliability and validity of this score to accurately distinguish high and low performing organisations. Three further factors should be addressed in this work. Firstly, validation of cut off points into groups require statistical justification. Secondly, weighting of the score components needs consideration; one score component did not significantly contribute to the association more than another, as shown by non-significant results in linkage analyses of individual components. However, input from a national expert clinical panel on the components of the score would contribute further to validation of individual components, or perhaps greater delineation of important factors within a particular component. This could be achieved in an academically robust way by use of a Delphi approach. This is a systematic process based on the results of multiple rounds of questionnaires sent to a panel of experts. The anonymous responses are aggregated and shared with the group after each round. (402) An alternative method is a survey, which has the advantage of being able to reach a larger number of stakeholders, but the disadvantage that results are less likely to reach a natural conclusion through consensus.

Future work should additionally consider studying other outcomes than those studied in this thesis. The outcomes studied in the linkage results (sections 3.3.4 and 4.3.5) are short term and do not address patient experience. Addressing these deficiencies would provide a greater depth of understanding. Further work is planned at exploring the association between service delivery factors and patient experience using the 'Cancer Patient Experience Survey'.

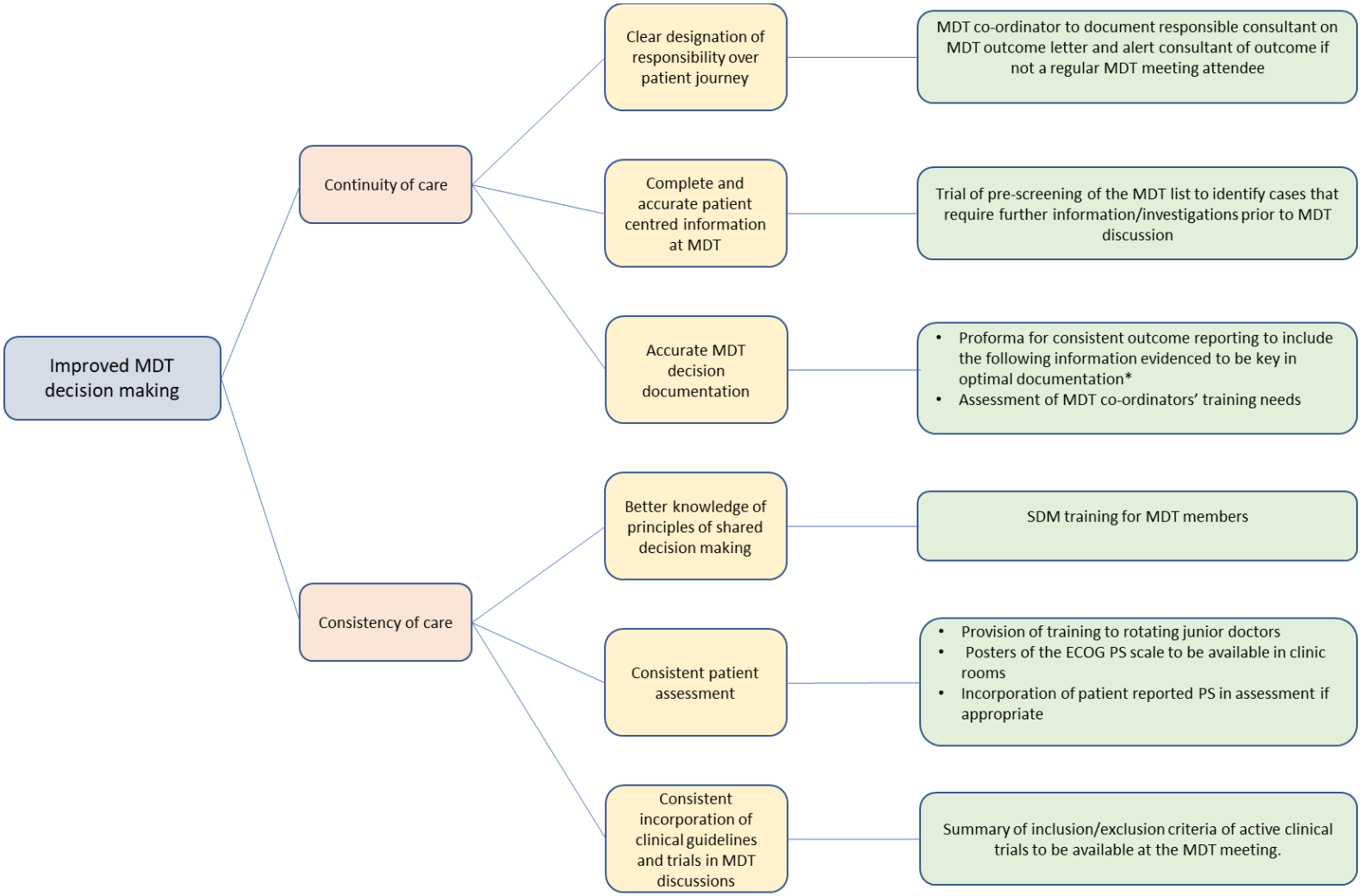
Finally, the detailed understanding of how socioeconomic status impacts on patient outcome was out of the scope of this work. Section 2.4.4 highlights the importance of this factor in

improving reducing variability in care. However, results in sections 3.3.4 and 4.3.5 show that socioeconomic status was not significantly associated with measured lung cancer outcomes contrary to published evidence mainly from US studies discussed in section 2.4.4. This may be reflective of the consistency and accuracy of completion of this data field but further robust investigation into this association in the UK health system is required.

### 6.2.3 Quality improvement strategies at a local multi-disciplinary team (MDT) level

The results presented in chapter 5 highlight several areas to improve the effectiveness of local decision making. Proposed interventions were discussed with the MDT team and refined to formulate a shared strategy. This strategy is summarised in Figure 6.1 as a driver diagram and are in the process of being implemented. It is based on the quality improvement principles of the model for improvement which provides a framework for developing, testing and implementing change and has been successfully used to implement change. (396) A repeat analysis of the service is planned as part of a PDSA cycle (plan, do, study, and act). These interventions address deficiencies found specific to the studied MDT. However, the methods used to identify contexts for change in this study can be generalised to other MDT's to understand local quality improvement metrics.

Figure 6.1: Quality improvement driver diagram.



## 6.3 Conclusion

The aim of this thesis is to identify factors other than patient and tumour variables that are evidenced to impact lung cancer outcomes. I have generated evidence that investing in lung cancer services so units can align services with recommendations made in the lung cancer commissioning guidance may drive up standards of care.

We are entering into an exciting era in lung cancer research where the development of new diagnostic and management options is occurring at a fast pace, particularly in the sphere of targeted therapies and immunotherapies. However, the findings from this thesis propose that the majority of patients in the UK will not be able to benefit from such advancements if deficiencies in investment and lung cancer service structure are not urgently addressed.

# APPENDICES

## A1 Full search strategy for scoping review

The following terms were used in each database.

### A1.1 Database: Medline (Ovoid)

URL: http://ovoid.sp.com

Date of search: 03 March 2017

1. Organisation of care ti,ab
2. Organization of care ti,ab
3. Delivery of care ti,ab
4. Hospital resources ti,ab
5. Patient outcome ti,ab
6. Or/1-4
7. 5 and 6
8. Limit 7 to humans

### A1.2 Database: Pubmed

URL: https://www.ncbi.nlm.nih.gov/pubmed

Date of search: 03 March 2017

#1 Organisation of care AND patient outcome ti, ab

#2 Organization of care AND patient outcome ti, ab

#3 Delivery of care AND patient outcome ti, ab

#4 Hospital resources AND patient outcome ti, ab

#5 Search #1 AND #2 AND #3 AND #4 Filters: Humans

## A1.3 Database: The Cochrane Library (Wiley) 2017: Cochrane Central Register of Controlled Trials (CENTRAL): Cochrane database of Systematic Reviews (CDSR) Issue 4 of 12; Database of Abstracts of Review of Effects (DARE); NHS EDD Issue 4 of 12

URL: http://www.cochrane.org/

Date of search: 03 March 2017

Search Strategy

#1 Organisation of care AND patient outcome

#2 Organization of care AND patient outcome

#3 Delivery of care AND patient outcome

#4 Hospital resources AND patient outcome

# A2 Modified ROBIN I tool and judgement criteria

## Table A2.1 Modified ROBIN I tool and judgement criteria

| **ROBIN I tool (modified)** | **Judging criteria** | |
|---|---|---|
| **Confounding**<br>Is there a potential for confounding of the effect of intervention?<br>Were appropriate analyses used to control for confounding?<br>Were confounders measured validly and reliably? | High | Not all measurable effect modifiers are identified a priori and statistically adjusted for |
| | Moderate | All measurable effect modifiers are statistically adjusted for but remains several difficult to measure factors. E.g. patient preference. |
| | Low | All effect modifiers are adjusted for. |
| | Unclear | Methods are unclear to make a judgement |
| **Selection**<br>Was selection of participants based on characteristics after the start of the intervention? | High | Includes registry data due to the inherent nature of difficult to accurately capture all data. Especially SEER data (>65 years old)/Medicare database (only those with that type of insurance) |
| | Moderate | Includes clinical databases with lots of exclusion criteria or <3 centres included or administrative databases. |
| | Low | Clinical database with non-restrictive inclusion/exclusion criteria |
| | Unclear | Methods are unclear to make a judgement |
| **Misclassification**<br>Were the intervention groups clearly defined?<br>Was information used to define the groups recorded at the start?<br>Could knowledge of the classification status | High | Definition of assigning the groups are dubious. For example, site of care studies examining distance patients travel for care and outcomes. GP practice is used as a proxy for residence or nearest hospital assumed to be the hospital patient used. |

| | | |
|---|---|---|
| influence the outcome? | | High risk of cross over. For example, both groups are at the same hospital at the same time.<br>The cut offs for assigning the groups are arbitrary i.e. hospital volume studies. |
| | Moderate | A proxy is used to represent the group;<br>Cohort using administrative data with groups in different hospitals. |
| | Low | Clinical studies with little potential for contamination or cross over.<br>Assessors are blinded. |
| | Unclear | Methods are unclear to make a judgement |
| **Performance**<br>Were there deviations from the intended intervention beyond what would be expected in usual practice?<br>Were co-interventions balanced against the groups?<br>Was the intervention implemented for most of the participants and did they adhere to the assigned intervention? | High | Difficult to isolate the interventions so likely that co-interventions are not balanced between the groups or not adjusted for properly. |
| | Moderate | Lots of interventions are assessed at the same time e.g. CCP and RDP. Co-interventions are likely to be more balanced between the groups. |
| | Low | Co-interventions are likely to balance between the groups, few deviations from intended intervention, and intervention implemented and adhered to in most or all cases. |
| | Unclear | Methods are unclear to make a judgement |
| **Attrition**<br>Was there outcome data for all or nearly all of the participants?<br>Were participants excluded for missing data? | High | Administrative or clinical data with more missing patients than expected where there is no formal adjustment or methods for accounting for such data. |

| | | |
|---|---|---|
| Were the proportions and reasons for missing data similar across interventions? | Moderate | Administrative or clinical data with small-moderate amount of missing data but accounted for via formal methods. |
| | Low | Clinical data or administrative data where all patients are accounted for. |
| | Unclear | Methods are unclear to make a judgement or no mention of missing data |
| **Detection**<br>Could outcome measurement have been influenced by knowledge of the intervention?<br>Were methods of outcome assessment comparable across groups?<br>Systematic errors in measurement of the outcome related to the intervention? | High | Patient aware of interventional status and outcome is subjective |
| | Moderate | Outcome is objective but potential to be affected by knowledge of interventional status. E.g. RDP studies measuring timeliness of care.<br>Patient unaware of interventional status (retrospective studies) but outcome is subjective. |
| | Low | Blinded or patient unaware of interventional status (retrospective) and outcome subjective/objective |
| | Unclear | Methods are unclear to make a judgement |
| **Reporting**<br>Could the reported results be because of multiple outcome measurements within the same outcome domain?<br>Multiple analyses of the intervention-outcome relationship?<br>Different subgroups? | High | Multiple statistical analyses with subgroup analyses and lots of potential variables that could be used in the model.<br>Did not cluster.<br>Used arbitrary cut off points. |
| | Moderate | Multiple variables or models/used a subgroup analysis but the model used to assess the primary outcome used reasonable statistical adjustment model, clustered and other reported outcomes not contrary to the primary outcome. |
| | Low | Outcome reported was not a subgroup analysis and there was no potential for multiple variables or models. |

| | | |
|---|---|---|
| | Unclear | Methods are unclear to make a judgement |
| **Overall** | High | One or more domain is high |
| | Moderate | No high domains and mostly moderate |
| | Low | All low |
| | Unclear | Methods are unclear to make a judgement |

# A3 Full search strategy for systematic review

The following terms were used in each database.

## A3.1 Database: Medline (Ovoid) and EMBASE

URL: http://ovoid.sp.com; https://www.embase.com

Date of search: 21 January 2019

1 health care personnel/ or "personnel".mp. or hospital personnel/
2. health care manpower/ or "manpower".mp. or manpower/ or manpower planning/
3. nursing staff/ or "nursing staff*".mp.
4. medical specialist/ or "specialist care".mp.
5. "workload".mp. or workload/
6. "staff workload".mp.
7. high volume hospital/
8. low volume hospital/
9. "multidisciplinary care".mp.
10. "interdisciplinary care".mp.
11. "patient care team".mp. or patient care/
12. "patient care planning".mp. or patient care planning/
13. health care delivery/
14. "Health services accessibility".mp.
15. "care co-ordination".mp.
16. "continuity of care".mp. or patient care/
17. health personnel attitude/ or "inter professional relations".mp.
18. "Timeliness".mp.
19. "wait time".mp.
20. "cancer care facilities".mp. or cancer center/
21. health care management/ or "care management".mp.
22. interdisciplinary communication/
23. "communication".mp.
24. "regional medical program*".mp.
25. "program* of care".mp. or health program/
26. "Organization and Administration"/ or Models, Organizational/ or models, organi*.mp.
27. lung cancer.mp. or exp lung cancer/
28. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26
29. 27 and 28
30. limit 30 to (human and English language and yr="2000 -Current" and (article or

conference paper or "review") and (adult <18 to 64 years> or aged <65+ years>) and "humans only (removes records about animals)")

## A3.2 Database: Pubmed

URL: https://www.ncbi.nlm.nih.gov/pubmed

Date of search: 21 January 2019

#1 Staff workload AND patient outcome AND Lung Cancer ti,ab

#2 Specialist care AND patient outcome AND Lung Cancer ti,ab

#3 Co-ordination of care AND patient outcome AND Lung Cancer ti,ab

#4 Clinical pathways AND patient outcome AND Lung Cancer ti,ab

#5 Record Keeping AND patient outcome AND Lung Cancer ti,ab

#6 Use of technology AND patient outcome AND Lung Cancer ti,ab

#7 Home care AND Patient outcome AND Lung Cancer ti,ab

## A3.3 Database: The Cochrane Library (Wiley) 2017: Cochrane Central Register of Controlled Trials (CENTRAL): Cochrane database of Systematic Reviews (CDSR) Issue 4 of 12; Database of Abstracts of Review of Effects (DARE); NHS EDD Issue 4 of 12

URL: http://www.cochrane.org/

Date of search: 21 January 2019

Search Strategy

#1 Staff workload AND patient outcome AND Lung Cancer

#2 Specialist care AND patient outcome AND Lung Cancer

#3 Co-ordination of care AND patient outcome AND Lung Cancer

#4 Clinical pathways AND patient outcome AND Lung Cancer

#5 Record Keeping AND patient outcome AND Lung Cancer

#6 Use of technology AND patient outcome AND Lung Cancer

#7 Home care AND Patient outcome AND Lung Cancer

# A4 Full results of the proportions, unadjusted and adjusted off ratios of patient, organisational and staffing factors by patient outcome (likelihood of curative intent treatment, receiving treatment within 62 days and one-year survival)

Table A4.1 Results of logistic regression analyses investigating the influence of patient and organisational features on the likelihood of receiving curative-intent treatment and clustering by NHS trust (n=29,793) for NSCLC patients

| | **No of patients** | **No who received curative-intent treatment** | **% receiving curative-intent treatment** | **Unadjusted OR (95% CI)** | **Adjusted OR (95% CI) *** | **$X^2$ p value for trends** |
|---|---|---|---|---|---|---|
| **Sex** | | | | | | |
| Male | 15,986 | 3,842 | 24.0 | 0.90 (0.85-0.95) | 0.90 (0.84-0.97) | <0.01** |
| Female | 13,807 | 3,591 | 26.0 | 1.00 | | |
| **Age** | | | | | | |
| <65years old | 6,325 | 1,973 | 31.2 | 1.00 | 1.00 | <0.001 |
| 65-80 years old | 16,053 | 4,613 | 28.7 | 0.88 (0.84-0.94) | 0.75 (0.67-0.83) | |
| >80 years old | 7,415 | 847 | 11.4 | 0.28 (0.26-0.32) | 0.22 (0.19-0.25) | |
| **Stage** | | | | | | |
| IA | 3,303 | 2,340 | 70.8 | 1.00 | 1.00 | <0.001 |
| IB | 2,183 | 1,509 | 69.1 | 0.92 (0.81-1.05) | 0.97 (0.84-1.12) | |
| IIA | 1,209 | 772 | 63.9 | 0.73 (0.63-0.84) | 0.69 (0.59-0.82) | |
| IIB | 1,144 | 640 | 56.0 | 0.52 (0.45-0.61) | 0.52 (0.43-0.62) | |
| IIIA | 3,490 | 1,342 | 38.5 | 0.26 (0.23-0.29) | 0.20 (0.17-0.23) | |
| IIIB | 2,462 | 356 | 14.5 | 0.07 (0.06-0.08) | 0.04 (0.04-0.05) | |
| IV | 14,468 | 373 | 2.6 | 0.01 (0.01-0.01) | 0.01 (0.01-0.01) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Missing | 1,534 | 101 | 6.6 | | | |
| **Performance status** | | | | | | |
| 0 | 4,344 | 2,233 | 51.4 | 1.00 | 1.00 | <0.001 |
| 1 | 7,616 | 2,761 | 36.3 | 0.53 (0.49-0.59) | 0.56 (0.50-0.63) | |
| 2 | 4,666 | 875 | 18.8 | 0.22 (0.19-0.25) | 0.21 (0.50-0.63) | |
| 3 | 4,427 | 162 | 3.7 | 0.04 (0.03-0.05) | 0.04 (0.03-0.05) | |
| 4 | 1,497 | 12 | 0.8 | 0.01 (0.00-0.01) | 0.01 (0.01-0.02) | |
| Missing | 7,243 | 1,390 | 19.2 | | | |
| **Townsend Quintile** | | | | | | |
| 1 (most affluent) | 4,093 | 1,029 | 25.1 | 1.00 | 1.00 | |
| 2 | 5,353 | 1,341 | 25.1 | 1.00 (0.90-1.10) | 0.99 (0.88-1.12) | 0.493 |
| 3 | 6,120 | 1,476 | 24.1 | 0.95 (0.86-1.05) | 0.90 (0.78-1.04) | |
| 4 | 6,733 | 1,690 | 25.1 | 1.00 (0.91-1.09) | 0.99 (0.86-1.14) | |
| 5 (least affluent) | 7,431 | 1,889 | 25.4 | 1.01 (0.93-1.10) | 0.94 (0.82-1.07) | |
| Missing | 63 | 8 | 12.7 | | | |
| **Charlson Index** | | | | | | |
| 0 | 9,737 | 2,537 | 26.1 | 1.00 | 1.00 | <0.001 |
| 1 | 4,886 | 1,780 | 36.4 | 1.63 (1.48-1.78) | 1.75 (1.49-2.04) | |
| 2 | 4,971 | 1,639 | 33.0 | 1.40 (1.27-1.54) | 1.52 (1.31-1.76) | |
| 3+ | 10,199 | 1,477 | 14.5 | 0.48 (0.43-0.53) | 1.27 (1.09-1.48) | |
| **Organisational score** | | | | | | |
| 0-4 | 7,045 | 1,594 | 22.6 | 1.00 | 1.00 | <0.001 |
| 5-7 | 14,298 | 3,310 | 23.2 | 1.03 (0.91-1.16) | 1.1 (0.92-1.33) | |
| 8-12 | 8,033 | 2,433 | 30.3 | 1.49 (1.25-1.77) | 1.61 (1.25-2.07) | |
| Missing | 417 | 96 | 23.0 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Treatment modalities** | | | | | | |
| **Biologics** | | | | | | |
| Offsite | 4,164 | 1,183 | 28.4 | 1.00 | 1.00 | <0.001** |
| Onsite | 25,212 | 6,154 | 24.4 | 0.81 (0.69-0.96) | 0.83 (0.65-1.05) | |
| Missing | 417 | 96 | 23.0 | | | |
| **Immunotherapy** | | | | | | |
| Onsite | 5,703 | 1,540 | 27.0 | 1.00 | | <0.001** |
| Onsite | 23,673 | 5,797 | 24.5 | 0.88 (0.75-1.02) | 0.86 (0.70-1.06) | |
| Missing | 417 | 96 | 23.0 | | | |
| **Stereotactic Radiotherapy** | | | | | | |
| Offsite | 21,168 | 5,900 | 27.9 | 1.00 | 1.00 | <0.001** |
| Onsite | 8,208 | 2,308 | 28.1 | 0.96 (0.81-1.14) | 1.25 (0.98-1.59) | |
| Missing | 417 | 96 | 23.0 | | | |
| **Surgery** | | | | | | |
| Offsite | 20,720 | 4,801 | 23.2 | 1.00 | 1.00 | <0.001** |
| Onsite | 8,656 | 2,536 | 29.3 | 1.37 (1.16-1.62) | 1.32 (1.03-1.68) | |
| Missing | 417 | 96 | 23.0 | | | |
| **Pulmonary Rehab** | | | | | | |
| Offsite | 9,738 | 2,243 | 23.0 | 1.00 | 1.00 | <0.001** |
| Onsite | 19,638 | 5,094 | 25.9 | 1.00 (0.83-1.21) | 1.18 (0.96-1.45) | |
| Missing | 417 | 96 | 23.0 | | | |
| **Smoking Cessation** | | | | | | |
| Offsite | 11,528 | 3,012 | 26.1 | 1.00 | 1.00 | <0.001** |
| Onsite | 17,848 | 4,325 | 24.2 | 0.90 (0.79-1.04) | 0.88 (0.72-1.09) | |
| Missing | 417 | 96 | 23.0 | | | |
| **Staffing provision using workload (cases/WTE)*** ** | | | | | | |
| **LCNS** | | | | | | |
| <80 | 3,714 | 1,103 | 29.7 | 1.00 | 1.00 | 0.002 |
| 80-199.9 | 23,326 | 5,639 | 24.2 | 0.75 (0.61- | 0.68 (0.51-0.92) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | 0.94) | | |
| ≥200 | 2,753 | 691 | 25.1 | 0.79 (0.46-1.36) | 0.80 (0.42-1.52) | |
| **Respiratory Physician** | | | | | | |
| <80 | 6,082 | 1,462 | 24.0 | 1.00 | 1.00 | |
| 80-199.9 | 11,228 | 2,851 | 25.4 | 1.08 (0.87-1.33) | 1.04 (0.80-1.35) | 0.255 |
| ≥200 | 12,483 | 3,120 | 25.0 | 1.05 (0.85-1.31) | 0.96 (0.74-1.26) | |
| **Medical Oncologist** | | | | | | |
| <100 | 8,403 | 2,125 | 25.3 | 1.00 | 1.00 | |
| 100-269.9 | 7,695 | 2,089 | 27.1 | 1.10 (0.89-1.36) | 1.25 (0.95-1.65) | 0.001 |
| ≥270 | 13,695 | 3,219 | 23.5 | 0.91 (0.78-1.06) | 0.88 (0.71-1.10) | |
| **Clinical Oncologist** | | | | | | |
| <180 | 8,113 | 2,122 | 26.2 | 1.00 | 1.00 | |
| 180-399.9 | 8,355 | 2,131 | 25.5 | 0.97 (0.77-1.21) | 0.96 (0.73-1.27) | <0.001 |
| ≥400 | 13,325 | 3,180 | 23.9 | 0.88 (0.76-1.03) | 0.82 (0.66-1.02) | |
| **Surgeon** | | | | | | |
| <160 | 8,007 | 2,202 | 27.5 | 1.00 | 1.00 | |
| 160-374.9 | 9,846 | 2,437 | 24.8 | 0.87 (0.71-1.06) | 0.86 (0.68-1.09) | <0.001 |
| ≥375 | 11,940 | 2,794 | 23.4 | 0.81 (0.66-0.98) | 0.65 (0.51-0.83) | |

* OR adjusted for patient variables only
** log likelihood odds ratio test
***WTE: Whole time equivalent of sessions dedicated to lung cancer work

Table A4.2 Results of logistic regression analyses investigating the influence of patient and organisational features on the likelihood of surviving one year and clustering by NHS trust (n=33,312)

| | **No of patients** | **No who survived one year** | **% surviving one year** | **Unadjusted OR (95% CI)** | **Adjusted OR (95% CI) *** | **$X^2$ p value for trends** |
|---|---|---|---|---|---|---|
| **Sex** | | | | | | |
| Male | 17,796 | 5,705 | 32.1 | 1.00 | 1.00 | <0.001** |
| Female | 15,516 | 5,842 | 37.7 | 0.78 (0.75-0.82) | 0.74 (0.70-0.78) | |
| **Age** | | | | | | |
| <65years old | 7,329 | 3,108 | 42.4 | 1.00 | 1.00 | <0.001 |
| 65-80 years old | 18,165 | 6,611 | 36.4 | 0.78 (0.74-0.82) | 0.74 (0.70-0.80) | |
| >80 years old | 7,818 | 1,828 | 23.4 | 0.41 (0.39-0.44) | 0.48 (0.43-0.52) | |
| **Stage** | | | | | | |
| IA | 3,359 | 2,616 | 77.9 | 1.00 | 1.00 | <0.001 |
| IB | 2,233 | 1,614 | 72.3 | 0.74 (0.65-0.84) | 0.73 (0.63-0.85) | |
| IIA | 1,269 | 830 | 65.4 | 0.54 (0.47-0.62) | 0.51 (0.41-0.63) | |
| IIB | 1,178 | 679 | 57.6 | 0.39 (0.34-0.45) | 0.39 (0.31-0.48) | |
| IIIA | 3,812 | 1,815 | 47.6 | 0.26 (0.23-0.45) | 0.24 (0.20-0.29) | |
| IIIB | 3,019 | 997 | 33.0 | 0.14 (0.13-0.16) | 0.12 (0.10-0.16) | |
| IV | 16,778 | 2,675 | 15.9 | 0.05 (0.05-0.06) | 0.06 (0.04-0.07) | |
| Missing | 1,664 | 321 | 19.3 | | | |
| **Performance status** | | | | | | |
| 0 | 4,816 | 2,927 | 60.8 | 1.00 | 1.00 | <0.001 |
| 1 | 8,681 | 4,061 | 46.8 | 0.57 (0.53-0.61) | 0.62 (0.56-0.69) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | 5,373 | 1,557 | 29.0 | 0.26 (0.24-0.29) | 0.32 (0.28-0.35) | |
| 3 | 4,877 | 644 | 13.2 | 0.10 (0.09-0.11) | 0.12 (0.12-0.14) | |
| 4 | 1,613 | 87 | 5.4 | 0.04 (0.03-0.05) | 0.05 (0.04-0.07) | |
| Missing | 7,952 | 2,271 | 28.6 | | | |
| **Townsend Quintile** | | | | | | |
| 1 (most affluent) | 4,534 | 1,650 | 36.4 | 1.00 | 1.00 | |
| 2 | 5,968 | 2,024 | 33.9 | 0.90 (0.83-0.97) | 0.86 (0.77-0.96) | |
| 3 | 6,787 | 2,376 | 35.0 | 0.94 (0.87-1.02) | 0.93 (0.84-1.04) | 0.0602 |
| 4 | 7,520 | 2,619 | 34.8 | 0.93 (0.86-1.01) | 0.91 (0.81-1.03) | |
| 5 (least affluent) | 8,431 | 2,876 | 34.1 | 0.90 (0.84-0.98) | 0.84 (0.75-0.94) | |
| Missing | 72 | 2 | 2.8 | | | |
| **Charlson Index** | | | | | | |
| 0 | 10,715 | 3,898 | 36.4 | 1.00 | 1.00 | |
| 1 | 5,405 | 2,528 | 46.8 | 1.54 (1.44-1.64) | 1.56 (1.17-2.04) | |
| 2 | 5,397 | 2,333 | 43.2 | 1.33 (1.25-1.42) | 1.42 (1.07-1.87) | 0.614 |
| 3+ | 11,795 | 2,788 | 23.6 | 0.54 (0.51-0.57) | 1.00 (0.77-1.29) | |
| **Organisational score **** | | | | | | |
| 0-4 | 7,843 | 2,430 | 31.0 | 1.00 | 1.00 | |
| 5-7 | 16,032 | 5,494 | 34.3 | 1.16 (1.10-1.23) | 1.29 (0.95-1.75) | <0.001 |
| 8-12 | 8,964 | 3,547 | 39.6 | 1.46 (1.37-1.55) | 1.50 (1.07-2.10) | |
| Missing | 473 | 76 | 16.1 | | | |
| **Onsite treatment modalities** | | | | | | |
| **Biologics** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Off site | 4,690 | 1,659 | | 1.00 | 1.00 | <0.001** |
| On site | 28,149 | 9,812 | | 0.98 (0.92-1.04) | 1.07 (0.85-1.36) | |
| Missing | 473 | 76 | 16.1 | | | |
| **Immunotherapy** | | | | | | |
| Offsite | 6,412 | 2.236 | 34.9 | 1.00 | 1.00 | <0.001** |
| Onsite | 26,427 | 9,235 | 34.9 | 1.00 (0.95-1.06) | 1.05 (0.84-1.30) | |
| Missing | 473 | 76 | 16.1 | | | |
| **Stereotactic radiotherapy** | | | | | | |
| Offsite | 23,679 | 7,737 | 33.7 | 1.00 | 1.00 | <0.001** |
| Onsite | 9,160 | 3,734 | 41.8 | 1.41 (1.35-1.49) | 1.48 (1.27-1.73) | |
| Missing | 473 | 76 | 16.1 | | | |
| **Surgery** | | | | | | |
| Offsite | 23,159 | 7,804 | 33.7 | 1.00 | 1.00 | <0.001** |
| Onsite | 9,680 | 3,667 | 37.9 | 1.20 (1.14-1.26) | 1.10 (0.86-1.41) | |
| Missing | 473 | 76 | 16.1 | | | |
| **Pulmonary Rehabilitation** | | | | | | |
| Onsite | 10,909 | 3,846 | 35.3 | 1.00 | 1.00 | <0.001** |
| Offsite | 21,930 | 7,625 | 34.8 | 0.98 (0.93-1.03) | 0.90 (0.76-1.07) | |
| Missing | 473 | 76 | 16.1 | | | |
| **Smoking Cessation** | | | | | | |
| Onsite | 12,892 | 4,587 | 35.6 | 1.00 | 1.00 | <0.001** |
| Offsite | 19,947 | 6,884 | 34.5 | 0.95 (0.91-1.00) | 0.97 (0.80-1.18) | |
| Missing | 473 | 76 | 16.1 | | | |
| **Staffing provision using workload (cases/WTE)** | | | | | | |
| **LCNS** | | | | | | |
| <80 | 4,170 | 1,411 | 33.8 | 1.00 | 1.00 | <0.001 |
| 80-199.9 | 26,631 | 9,162 | 34.4 | 1.03 (0.96-1.10) | 1.12 (0.80-1.61) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| ≥200 | 2,511 | 974 | 38.8 | 1.24 (1.12-1.37) | 1.43 (0.93-2.22) | |
| **Respiratory Physician** | | | | | | |
| <80 | 6,837 | 2,224 | 32.5 | 1.00 | 1.00 | |
| 80-199.9 | 12,535 | 4,446 | 35.5 | 1.14 (1.07-1.21) | 1.15 (0.92-1.43) | 0.062 |
| ≥200 | 13,940 | 4,877 | 35.0 | 1.12 (1.05-1.19) | 1.09 (0.85-1.41) | |
| **Medical Oncologist** | | | | | | |
| 0-100 | 9.480 | 3,021 | 31.9 | 1.00 | 1.00 | |
| 100-269.9 | 8,560 | 3,236 | 37.8 | 1.30 (1.22-1.38) | 1.47 (1.10-1.98) | <0.001 |
| ≥270 | 15,272 | 5,290 | 34.6 | 1.13 (1.07-1.20) | 1.24 (0.91-1.68) | |
| **Clinical Oncologist** | | | | | | |
| <180 | 9,143 | 3,176 | 34.7 | 1.00 | 1.00 | |
| 180-399.9 | 9.286 | 3,421 | 36.8 | 1.10 (1.03-1.16) | 1.15 (0.9101.45) | 0.112 |
| ≥400 | 14,883 | 4,950 | 33.3 | 0.94 (0.89-0.99) | 0.94 (0.71-1.24) | |
| **Surgeon** | | | | | | |
| <160 | 8,951 | 3,276 | 36.6 | 1.000 | 1.00 | |
| 160-374.9 | 11,023 | 3,892 | 35.3 | 0.95 (0.90-1.00) | 0.99 (0.80-1.22) | <0.001 |
| ≥375 | 13,338 | 4,379 | 32.8 | 0.85 (0.80-0.90) | 0.81 (0.61-1.07) | |

* OR adjusted for patient variables only
**Log likelihood odds ratio test
***WTE: Whole time equivalent of sessions dedicated to lung cancer work

Table A4.3 Results of logistic regression analyses investigating the influence of patient and organisational features on the likelihood of receiving treatment within 62 days and clustering by NHS trust (n=33,312)

| | **No of patients** | **No who received treatment within 62 days** | **% receiving treatment within 62 days** | **Unadjusted OR (95% CI)** | **Adjusted OR (95% CI) *** | **$X^2$ p value for trends** |
|---|---|---|---|---|---|---|
| **Sex** | | | | | | |
| Male | 17,796 | 8,982 | 50.5 | 1.00 | 1.00 | 0.243** |
| Female | 15,516 | 7,791 | 50.2 | 1.01 (0.97-1.05) | 0.97 (0.92-1.02) | |
| **Age** | | | | | | |
| <65years old | 7,329 | 5,097 | 69.5 | 1.00 | 1.00 | <0.001 |
| 65-80 years old | 18,165 | 9,978 | 54.9 | 0.53 (0.50-0.57) | 0.60 (0.56-0.64) | |
| >80 years old | 7,818 | 1,698 | 21.7 | 0.12 (0.11-0.13) | 0.18 (0.16-0.19) | |
| **Stage** | | | | | | |
| IA | 3,359 | 1,954 | 59.2 | 1.00 | 1.00 | <0.001 |
| IB | 2,233 | 1,292 | 57.9 | 0.99 (0.89-1.10) | 1.02 (0.90-1.17) | |
| IIA | 1,269 | 750 | 59.1 | 1.04 (0.91-1.18) | 1.04 (0.87-1.24) | |
| IIB | 1,178 | 653 | 55.4 | 0.89 (0.78-1.02) | 1.00 (0.83-1.21) | |
| IIIA | 3,812 | 2,210 | 58.0 | 0.99 (0.90-1.09) | 1.08 (0.94-1.23) | |
| IIIB | 3,019 | 1,899 | 62.9 | 1.22 (1.10-1.35) | 1.36 (1.17-1.59) | |
| IV | 16,778 | 7,738 | 46.1 | 0.62 (0.57-0.66) | 0.81 (0.69-0.94) | |
| Missing | 1,664 | 277 | 16.6 | | | |
| **Performance status** | | | | | | |
| 0 | 4,816 | 3,855 | 80.0 | 1.00 | 1.00 | <0.001 |
| 1 | 8,681 | 6,141 | 70.7 | 0.60 (0.55- | 0.68 (0.61- | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | 0.66) | 0.76) | |
| 2 | 5,373 | 2,694 | 50.1 | 0.25 (0.23-0.27) | 0.32 (0.28-0.37) | |
| 3 | 4,877 | 1,031 | 21.1 | 0.07 (0.06-0.73) | 0.10 (0.08-0.11) | |
| 4 | 1,613 | 149 | 9.2 | 0.03 (0.02-0.03) | 0.04 (0.03-0.05) | |
| Missing | 7,952 | 2,903 | 36.5 | | | |
| **Townsend Quintile** | | | | | | |
| 1 (most affluent) | 4,534 | 2,408 | 53.1 | 1.00 | 1.00 | |
| 2 | 5,968 | 3,040 | 50.9 | 0.92 (0.85-0.99) | 0.88 (0.81-0.97) | <0.001 |
| 3 | 6,787 | 3,369 | 49.6 | 0.87 (0.81-0.94) | 0.84 (0.76-0.93) | |
| 4 | 7,520 | 3,727 | 49.6 | 0.88 (0.82-0.94) | 0.84 (0.76-0.93) | |
| 5 (least affluent) | 8,431 | 4,205 | 49.9 | 0.88 (0.82-0.94) | 0.80 (0.71-0.90) | |
| Missing | 72 | 24 | 33.3 | | | |
| **Charlson Index** | | | | | | |
| 0 | 10,715 | 5,484 | 51.2 | 1.00 | 1.00 | |
| 1 | 5,405 | 3,108 | 57.5 | 1.29 (1.21-1.38) | 1.47 (1.31-1.66) | |
| 2 | 5,397 | 2,674 | 49.5 | 0.94 (0.88-1.00) | 1.29 (1.31-1.66) | <0.001 |
| 3+ | 11,795 | 5,507 | 46.7 | 0.84 (0.79-0.88) | 1.34 (1.19-1.51) | |
| **Organisational score *** | | | | | | |
| 0-4 | 7,843 | 3,714 | 47.4 | 1.00 | 1.00 | |
| 5-7 | 16,032 | 7,966 | 49.7 | 1.10 (1.04-1.16) | 1.12 (0.96-1.31) | |
| 8-12 | 8,964 | 4,890 | 54.6 | 1.22 (1.26-1.42) | 1.39 (1.12-1.74) | <0.001 |
| Missing | 473 | 203 | 42.9 | | | |
| **Diagnostic modalities** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **EBUS** | | | | | | |
| Offsite | 8,347 | 3,911 | 46.9 | 1.00 | 1.00 | <0.001** |
| Onsite | 24,492 | 12,659 | 51.7 | 1.21 (1.15-1.28) | 1.20 (1.04-1.39) | |
| Missing | 473 | 203 | 42.9 | | | |
| **PET scan** | | | | | | |
| Offsite | 19,772 | 9,549 | 48.3 | 1.00 | 1.00 | <0.001** |
| Onsite | 13,067 | 7,021 | 53.7 | 1.24 (1.19-1.30) | 1.27 (1.09-1.48) | |
| Missing | 473 | 203 | 42.9 | | | |
| **Thoracoscopy** | | | | | | |
| Offsite | 12,758 | 5,911 | 46.3 | 1.00 | 1.00 | <0.001** |
| Onsite | 20,554 | 10,659 | 51.9 | 1.16 (1.11-1.21) | 1.17 (1.02-1.3) | |
| Missing | 473 | 203 | 42.9 | | | |
| **EGFR/ALK testing** | | | | | | |
| Offsite | 25,725 | 12,643 | 49.1 | 1.00 | 1.00 | <0.001** |
| Onsite | 7,114 | 3,927 | 55.2 | 1.27 (1.21-1.34) | 1.38 (1.13-1.69) | |
| Missing | 473 | 203 | 42.9 | | | |
| **PDL-1 testing** | | | | | | |
| Offsite | 28,509 | 14,088 | 49.4 | 1.00 | 1.00 | <0.001** |
| Onsite | 4,330 | 2,482 | 57.3 | 1.37 (1.29-1.47) | 1.50 (1.12-2.00) | |
| Missing | 473 | 203 | 42.9 | | | |
| **Treatment modalities** | | | | | | |
| **Biologics** | | | | | | |
| Offsite | 4,690 | 2,368 | 50.5 | 1.00 | 1.00 | 0.062** |
| Onsite | 28,149 | 14,202 | 50.5 | 1.00 (0.94-1.06) | 1.07 (0.89-1.30) | |
| Missing | 473 | 203 | 42.9 | | | |
| **Immunotherapy** | | | | | | |
| Offsite | 6,412 | 3,169 | 49.4 | 1.00 | 1.00 | 0.001** |
| Onsite | 26,427 | 13,401 | 50.7 | 1.05 (1.00- | 1.12 (0.95- | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | 1.11) | 1.32) | |
| Missing | 473 | 203 | 42.9 | | | |
| **Stereotactic radiotherapy** | | | | | | |
| Offsite | 23,679 | 11,453 | 48.4 | 1.00 | 1.00 | <0.001** |
| Onsite | 9,160 | 5,117 | 55.9 | 1.35 (1.29-1.42) | 1.45 (1.24-1.70) | |
| Missing | 473 | 203 | 42.9 | | | |
| **Surgery** | | | | | | |
| Offsite | 23,634 | 11,334 | 48.0 | 1.00 | 1.00 | <0.001** |
| Onsite | 9,680 | 5,236 | 54.1 | 1.23 (1.17-1.29) | 1.27 (1.06-1.52) | |
| Missing | 473 | 203 | 42.9 | 0.78 (0.65-0.94) | 0.57 (0.35-0.93) | |
| **Staffing provision using workload (cases/WTE)*** ** | | | | | | |
| **LCNS** | | | | | | |
| 0-69.9 | 4,170 | 2,142 | 51.4 | 1.00 | 1.00 | 0.061 |
| 70-119.9 | 26,631 | 13,291 | 49.9 | 0.94 (0.88-1.01) | 0.95 (0.74-1.22) | |
| 120-1850 | 1,340 | 1,171 | 87.4 | 0.91 (0.82-1.01) | 1.15 (0.73-1.81) | |
| **Respiratory Physician** | | | | | | |
| 0-80 | 6,837 | 3,296 | 48.2 | 1.00 | 1.00 | 0.006 |
| 80-200 | 12,535 | 6,316 | 50.4 | 1.09 (1.03-1.16) | 1.13 (0.95-1.35) | |
| >200 | 13,940 | 7,161 | 51.4 | 1.13 (1.07-1.20) | 1.14 (0.96-1.35) | |
| **Medical Oncologist** | | | | | | |
| 0-100 | 9,480 | 4,800 | 50.6 | 1.00 | 1.00 | 0.589 |
| 100-270 | 8,560 | 4,295 | 50.2 | 0.98 (0.93-1.04) | 1.00-0.80-1.25) | |
| >270 | 15,272 | 7,678 | 50.3 | 0.99 (0.94-1.04) | 0.99 (0.82-1.18) | |
| **Clinical Oncologist** | | | | | | |
| 1-180 | 9,143 | 4,743 | 51.2 | 1.00 | 1.00 | <0.001 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 180-400 | 9,286 | 4,759 | 51.2 | 0.98 (0.92-1.03) | 0.99 (0.80-1.23) | |
| >400 | 14,883 | 7,271 | 48.9 | 0.89 (0.84-0.93) | 0.87 (0.73-1.05) | |
| **Surgeon** | | | | | | |
| 0-160 | 8,951 | 4,681 | 52.3 | 1.00 | 1.00 | |
| 160-375 | 11,023 | 5,642 | 51.2 | 0.96 (0.90-1.01) | 0.92 (0.75-1.13) | <0.001 |
| >375 | 13,338 | 6,450 | 48.4 | 0.85 (0.81-0.90) | 0.80 (0.66-0.97) | |

* OR adjusted for patient variables only

**log likelihood odds ratio test

***WTE: Whole time equivalent of sessions dedicated to lung cancer work

# A5 Topic guide for semi structured interviews

## A5.1 Topic guide for interviews: first iteration

Introduction: I am doing a project looking at decision making in lung cancer. I am going to ask you some questions and I am interested to hear about your thoughts and experiences. Please feel free to be open and honest. I will kindly ask that you do not mention any names or personal identifiers.

1. In your experience what influences decisions about treatment in lung cancer?
   PROMPTS: past experiences with similar patients; the MDT, guidelines, patient preference/characteristics
2. In your opinion who should make decisions about lung cancer treatment. Why do you feel this way?
   Rephrase: Do you think lung cancer patients should be involved? Who do you think the final treatment choice should be made by?
3. What is your understanding of the term: 'Shared Decision Making'?
   What are the qualities involved in good SDM?
4. Is SDM appropriate in all treatment decision making contexts in lung cancer?
   Rephrase: Is there a situation where SDM is not appropriate/less suitable? Do you think all treatment options should be discussed with the patient?
   Are there any situations where you feel SDM may not be appropriate? Why do you feel this is the case?
5. What are the barriers to SDM?
   What do you feel are the barriers to SDM?
   What do you feel are the risks and benefits to SDM?
   PROMPT: patient/organisational barriers
   REPHRASE: What makes it difficult to apply SDM in current clinical practice? What circumstanced would you like to apply SDM but feel you are unable to at present?
6. Do you feel confident/adequately trained to implement SDM into your practice? Why is this?
7. Can you think of any interventions that could facilitate SDM?
   Are there any methods or interventions that you feel that could facilitate SDM?

Thank you for your time. Is there anything else you would like to discuss?

## A5.2 Topic Guide for interviews: second iteration

Introduction: I am doing a project looking at decision making in lung cancer. I am going to ask you some questions and I am interested to hear about your thoughts and experiences. Please feel free to be open and honest. I will kindly ask that you do not mention any names or personal identifiers.

1. Question 1

In your experience what influences decisions about treatment in lung cancer?
In your experience, how does a team come to a decision about lung cancer treatment?
What do you think about the assessment of performance status?
What information do you need? What are the barriers to accessing that information? Is there anything you think that does not get discussed that should?
Are there times when a decision is not made? Why?
How much decision making occurs outside the meeting?
PROMPTS: past experiences with similar patients; the MDT; guidelines; patient preference/characteristics

2. Question 2

In your opinion who should make decisions about lung cancer treatment. Why do you feel this way?
Rephrase: Do you think lung cancer patients should be involved? Who do you think the final treatment choice should be made by?

3. Question 3

Are there any situations where you feel SDM may not be appropriate? Why do you feel this is the case?
REPHRASE: Is there a situation where SDM is not appropriate/less suitable? Do you think all treatment options should be discussed with the patient?

4. Question 4

What do you feel are the barriers to SDM?
In your experience, how much do you tend to know about patient preferences?
What extent do they influence decision making?
PROMPT: patient/organisational barriers
REPHRASE: What makes it difficult to apply SDM in current clinical practice? What circumstanced would you like to apply SDM but feel you are unable to at present?

5. Question 5

How can we as an organisation improve in-cooperating SDM into clinical practice?
The MDT? Efficiency of the MDT? Do you think MDT's lead to better decisions for patients?
Do you think there are times when poor or suboptimal decisions are made and why?
Cases that have been re-discussed several times.
Targets and timelines?
How can we accurately portray the view of the patient at MDT?

Reporting of outcomes?
Decision aids and guidelines, we could use?
Proformas or patient information videos/leaflets?

6. Question 6

Do you feel confident/adequately trained to implement SDM into your practice?
Why is this?

7. Question 7

Are there any methods or interventions that you feel that could facilitate SDM?

Thank you for your time. Is there anything else you would like to discuss?

## A5.3 Topic Guide for multi-disciplinary team (MDT) co-ordinator interviews

Introduction: The purpose is to get your thoughts and view on the lung MDT meeting and the process of decision making and also about ways you think we can improve this process and things that would help you do your role. Please feel free to be open and honest. I will kindly ask that you do not mention any names or personal identifiers.

1. Tell me about your job role? What are your duties as part of your role? Do you feel your duties are suitable for your role/are you happy with them?
2. How efficient do you think the MDT meeting is?
3. Do you think that patient views are adequately in cooperated into the decisions made in the MDTM?
4. In your view who contributes to decision making in the meeting. Does anyone professional group carry more weight?
5. Do you feel you are able to speak up in MDT meetings such as to prompt for mandatory data items?
6. Can you think of any barriers there are too decision making in the MDT?
7. Can you think of ways we can improve the meeting/make the pathway more efficient? Ways we can improve decision-making.
8. What training have you received for your role (courses/in house training)? Have you heard about an e learning tool for MDT co-ordinators and the MDT co-ordinator pack produced by UKACR?
9. What training do you think would be useful to have to fulfil your duties that you have not received? How easy is it to prepare for meetings? What would help you do this easier?

Thank you for your time. Is there anything else you would like to discuss?

## A5.4 Topic Guide for pathologist interviews

Introduction: I am investigating how we can improve decision making in lung cancer within this MDT and pathologists are key to this process I am going to ask you some questions and I am interested to hear about your thoughts and experiences. Please feel free to be open and honest. I will kindly ask that you do not mention any names or personal identifiers.

I am keen to find out your thoughts and opinions about how you feel your job plan reflects the amount of time needed to dedicate to lung cancer.

I am also keen to explore practical ways you can think changes in the structure or organisation of the service can aid you?

In your experience of the MDT, what influences decisions about lung cancer?

What do you understand about the term-shared decision-making? What do you think about SDM?

In your experience how much do we tend to know about patient preferences in the MDT and what extent do they influence decision making?

Do you think that MDT's lead to better decisions for patients? How much decision making for you occurs outside the MDT?

How can we improve the efficiency of the MDT? How do targets influence decision-making?

Are there any methods or interventions that you feel could facilitate SDM?

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