Thoracic Surgery

The Society for Cardiothoracic Surgery in Great Britain & Ireland

Third
National Thoracic Surgery Activity & Outcomes Report

2018

Prepared by

The Society for Cardiothoracic Surgery in Great Britain & Ireland

Dendrite Clinical Systems

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Prepared by

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in Great Britain & Ireland

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Dendrite Clinical Systems

The Society for Cardiothoracic Surgery in Great Britain & Ireland operated the National Thoracic Surgery Database in partnership with Dendrite Clinical Systems Limited. The Society gratefully acknowledges the assistance of Dendrite Clinical Systems for:

- building, maintaining & hosting the web registry
- data analysis and
- publishing this report

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- Kieran McManus — Chapter Lead: Oesophageal Surgery
- Juliet King
- Alan Kirk
- Eric Lim
- Carol Tan — Chapter Lead: Mesothelioma Surgery
- Ira Goldsmith

Working group: Hospital Episode Statistics Pilot Audit Project

The pilot study reported in section three was performed by the Clinical Evaluation Unit (CEU) at the Royal College of Surgeons of England. An *ad hoc* working group formed between the SCTS and the CEU oversaw the project, comprising:

- Graham Cooper — President SCTS
- David Jenkins — Chair, SCTS Audit Committee
- Doug West — SCTS Thoracic Audit Lead
- David Cromwell — Director, CEU
- Irene Kreis — Epidemiologist, CEU

Foreword from the President

I am really proud on behalf of the SCTS and all its members to see the publication of the Third Blue Book on thoracic surgical activity and outcomes. One cannot underestimate the amount of work, which has been put in over many years within all the thoracic surgical Units throughout the United Kingdom and Ireland to collect and collate the data. The SCTS audit team have likewise done a fantastic job in ensuring an almost 100% completion of data collection, and subsequently carrying out the analysis to produce this detailed but very readable report. I should like to specifically thank Doug West for leading the thoracic surgery audit project over the last four years and for his inspiration and enthusiasm, and also colleagues at Dendrite in their support for the compilation of this very impressive report.

Thoracic surgery has expanded significantly over the last decade or so, especially for the treatment of lung cancer. The reasons for the increase are multifactorial, but very necessary given the long-standing nihilism surrounding this dreadful disease. The introduction of the NHS cancer plan, the formation of lung cancer teams, the creation of the post of lung cancer specialist nurses and the National Lung Cancer Audit are all important positive factors which have led to the increase in the work. But it is the increase in thoracic surgical capacity in cardiothoracic units to allow this to happen which has been the most important factor, especially the rapid increase in the number of specialist thoracic surgeons and thoracic surgical teams whose prime focus is thoracic surgery. And with the recent and clear success of lung cancer screening programmes in identifying those patients with disease at an earlier stage, it is likely that the number of patients who can benefit from thoracic surgery will continue to increase.

The three data sources that make up this report are all interesting in their genesis and history. The long-term success of the Thoracic Surgical Register is undoubtedly due to its simplicity and usefulness for surgeons, which accounts for it being the longest-running thoracic surgical audit project in the world. The SCTS Thoracic Surgical Database was conceived as a way of improving on the Register, but was sadly rendered redundant by the incorporation of lung cancer surgery into the National Lung Cancer Audit, which is reported separately under the auspices of HQIP. The SCTS has worked closely with this audit in helping to produce very useful data, but recognises that the audit only analyses up to a third of the work done by thoracic surgeon. The recent SCTS pilot project using HES data to analyse pneumothorax and pleural sepsis surgery is very exiting in both its apparent accuracy and the in the usefulness of the outputs which are reported here. The SCTS will continue to champion activity and outcomes reporting, to highlight variations in practice, and to improve the care of our patients.

Richard Page

President, the Society for Cardiothoracic Surgery

Invited commentaries

This Third Report from the Society is the most comprehensive yet, and provides a level of detail that is not available in other publications. It shows the considerable progress that has been made in thoracic surgery, particularly from 2005, due to a combination of a greater number of specialised thoracic surgeons, the use of updated clinical guidelines, changes to the wider multidisciplinary team and the use of audit to inform and change practice. One of the most important findings is that of the increase in lung cancer resections since 2005. Although this coincides with the start of the National Lung Cancer Audit, which undoubtedly played a role, there was also a significant increase in the number thoracic surgeons. We also know that 5-year survival has increased above that expected in the United Kingdom, reflecting this increased resection rate. A greater number of specialist surgeons is the key to achieving better resection rates in the United Kingdom and with that, better outcomes. Now that screening with low dose CT is being implemented in pilots and has, following preliminary results from the NELSON trial, the best chance yet of being implemented as a national programme, there will be a further demand on thoracic surgeons. The Report also quantifies the massive shift from pneumonectomy to lobectomy and the marked increase in video assisted thoracic surgery (VATS). This is undoubtedly the main reason for the improved early surgical survival, and contributed to by the improved accuracy of diagnosis and staging. The latter is also contributing to the continued reduction in futile thoracotomy where patients, often desperate for a chance of cure, can be advised with more confidence.

Two key challenges remain in thoracic surgery for lung cancer (and for the wider lung cancer service). The first is to reduce the variation seen by geographical area in resection rates. Reducing this variation is incredibly important if outcome is to be improved in the whole population. There is evidence that more people have resection for their lung cancer if they are first referred to a centre with thoracic surgery on site. Surgeons need to be aware of the need to ensure local MDTs evaluate all patients and monitor the resection rates in the units they serve. The National Lung Cancer Commissioning Guidance, produce by NHSE, sets out how to commission services in a way that should reduce variation. The second challenge is to address the variation in time to treatment, as shown in this report. There is evidence for faster pathways producing better outcomes - with some of the better evidence from early stage, surgically resected cases. Thoracic surgeons can do this by implementing the recommendations in the National Optimal Lung Cancer Pathway for time to clinic review and treatment. If these two factors can be addressed, it is likely that the next report will show a further marked increase in successful thoracic surgery and associated better outcomes.

David R Baldwin

Chair, Clinical Expert Group for Lung Cancer, NHSE; Consultant Respiratory Physician and Honorary Professor of Medicine, Nottingham University Hospitals and University of Nottingham

It is a privilege to provide comment on this report. It is important to reflect, that every lung cancer operation listed herein, represents a patient, family and wider social community, dealing with a cancer diagnosis, for which this surgery offers hope and the potential of cure.

In a disease that historically has been categorised by much negativity, late diagnosis and poor prognosis, there is much to celebrate in the improvements seen in this surgical data, collected over the past 35 years. The large increase in lung cancer surgery overall is to be warmly welcomed, This means that today, many more patients are being offered treatment with curative intent, than when data collection started in 1980. The increase in VATS and big reduction in pneumonectomy procedures means that patients have a lower risk of serious adverse events and shorter hospital stays. For me, the most striking feature of the Report is the dramatic fall in 'open and close' operations over the past 35 years - this, having such a huge impact on improving patient experience and outcome.

As we look to the SCTS database, for data collected from 2014 to 2017, in 14 hospitals in England, we find a wealth of information on thoracic surgical activity and outcome. At an individual hospital level, this data provides the opportunity to benchmark and improve performance. It also provides a focus for research and for wider discussion on the quality and configuration of our thoracic surgical health services.

The significance of high quality data cannot be overestimated. In the words of W Edwards Deming, *In God we Trust, all others bring data*. I acknowledge the sheer volume of work required in developing this Report and congratulate all those involved, in ensuring the quality of the data presented here.

Jesme Fox

Medical Director, Roy Castle Lung Cancer Foundation

The publication of this Third National Activity and Outcomes Report in Thoracic Surgery was made possible by a grant from Ethicon. Here Chris Brooks, Specialty Manager for Ethicon in the United Kingdom and Ireland reflects on the project, and on the progress made in thoracic surgery:

It gives me great pleasure on behalf of Ethicon to be able to acknowledge our support in the publication of the Third National Thoracic Surgery Activity & Outcomes Report. As an organisation we are continuously humbled by the professionalism and level of dedication to patient care shown by thoracic departments and their teams across the United Kingdom & Ireland in what is a challenging disease to treat. The results from the third database report are testament to this; more resections completed by fewer centres, an increase in VATS procedures and fewer pneumonectomies for example. However, there are still challenges in areas such as the variation in resection rates across these nations, and common adverse events like prolonged air leaks that increase length-of-stay, as noted in the report.

At Ethicon we are dedicated to supporting the thoracic specialty to reach more patients and restore more lives. In 2019 we will be amplifying our medical education programs to help further the adoption of VATS procedures and enhance the safe and effective use of our products. We are very proud to be able to continue our support of the SCTS Trainee Pathway, which we feel is an extremely valuable investment in the future of the specialty. In addition we will be researching further into common intra-operative complications, including air leaks, and their causes in order to better understand them.

Chris Brooks

Thoracic Specialty Manager, United Kingdom & Ireland, Ethicon

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Key messages

- This is the Third National Database Report. It includes an update of the thoracic registry, with data from 1980-2015. It also reports the SCTS thoracic database, which ran from 2014-2017, and a pilot project reporting unit outcomes in pneumothorax and pleural sepsis surgery using Hospital Episode Statistics data.
- The Thoracic Register has collected data in thoracic surgery from the great majority of United Kingdom and Irish units since 1980. This makes it one of the longest running and most complete national register in thoracic surgery anywhere in the world.
- Units size varies markedly, from 1,956 cases over five years at the Golden Jubilee Hospital in Glasgow to 245 cases over the same period at the subsequently closed Royal Devon and Exeter Hospital in Exeter. There has been a trend over time towards fewer, larger units.
- Around 2006, lung cancer surgery activity began to rise. Before this, activity was static at around 4,000 operations *per* year. By 2014-2015, over 7,000 were preformed.
- A large increase in thoracoscopic (VATS) resections is responsible for most of the recent increase in lung cancer surgery, rising from 749 cases in 2010-2011 to 2,753 in 2014-2015, an increase of more than 3.5 times. By 2014-2015, 40% of lobectomies and more than 50% of sublobar resections were performed by VATS.
- Several markers of quality have improved significantly over the 35 years of the register. Futile or *open and close* thoracotomies have declined from one-quarter of all attempted operations in 1980 to around 2% today. Pneumonectomy, removal of the whole lung, accounts for about 5% of lung cancer operations, down from 40% at the start of the register.
- Oesophageal surgery has moved to upper gastrointestinal surgeons. These resections are now rarely performed by thoracic surgeons, and in a minority of units.
- Other low volume procedures, for example radical surgery for mesothelioma, chest wall tumour surgery and emphysema surgery is concentrated in a few units.
- The 2014-2017 database project collected data from 14 hospitals.
- 45% of patients in the database had a pre-op FEV1 of <80% predicted. More than half of cancer resection patients had a BMI above 25 kg m^{-2}.
- Median length-of-stay after lung cancer surgery was five days. 75% of patients did not suffer any complication. Of those who did, air leak (10.5% of cases) was the commonest adverse event.
- In HES data, a sixth of NHS admissions with pneumothorax involve a surgical procedure. 30-day mortality is 0.5%, and one in ten are readmitted within 30 days. 3.4% have a further procedure on the same side within a year.
- In HES data, 14% of 23,634 empyema admissions from 2009-2014 involved an operation. About a quarter of operations occurred after drain placement. Median length-of-stay in uncomplicated empyema was 6 days. Mortality for excision procedures in this group was 0.3%, and for surgical excision was 1.2%. Coexistent respiratory disease and cancer was associated with worsening outcomes.

A note on the conventions used throughout this report

There are several conventions used in the report in an attempt to ensure that the data are presented in a simple and consistent way. These conventions relate largely to the tables and the graphs, and some of these conventions are outlined below.

The specifics of the data used in any particular analysis are made clear in the accompanying text, table or chart. For example, many analyses sub-divide the data on the basis of the kind of operation performed, and the titles for both tables and charts will reflect this fact.

Conventions used in tables

On the whole, unless otherwise stated, the tables and charts in this report record the number of procedures (see the example below).

Table 3.01 **Primary resections for lung cancer:** age and gender; financial years 2014-2016

		Gender		
		Male	**Female**	**All**
Age at surgery / years	<45	46	38	**84**
	45-49	34	37	**71**
	50-54	77	82	**159**
	55-59	97	148	**245**
	60-64	206	211	**417**
	65-69	315	312	**627**
	70-74	316	261	**577**
	75-79	261	203	**464**
	80-84	123	114	**237**
	>84	30	20	**50**
	All	**1,505**	**1,426**	**2,931**

Each table has a short title that is intended to provide information on the subset from which the data have been drawn, such as the patient's gender or particular operation sub-grouping under examination.

The numbers in each table are colour-coded so that entries with complete data for all of the components under consideration (in this example both age at surgery and the patient's gender) are shown in regular black text. If one or more of the database questions under analysis is blank, the data are reported as unspecified in orange text. The totals for both rows and columns are highlighted as emboldened text.

Some tables record percentage values; in such cases this is made clear by the use of an appropriate title within the table and a % symbol after the numeric value.

Rows and columns within tables have been ordered so that they are either in ascending order (age at procedure: <20, 20-24, 25-29,30-34, 35-39 years, *etc.*; post-procedure stay 0, 1, 2, 3, >3 days; *etc.*) or with negative response options first (No; None) followed by positive response options (Yes; One, Two, *etc.*).

Row and column titles are as detailed as possible within the confines of the space available on the page. Where a title in either a row or a column is not as detailed as the authors would have liked, then footnotes have been added to provide clarification.

There are some charts in the report that are not accompanied by data in a tabular format. In such cases the tables are omitted for one of a number of reasons:

- insufficient space on the page to accommodate both the table and graph.
- there would be more rows and / or columns of data than could reasonably be accommodated on the page (for example, Kaplan-Meier curves).
- the tabular data had already been presented elsewhere in the report.

Conventions used in graphs

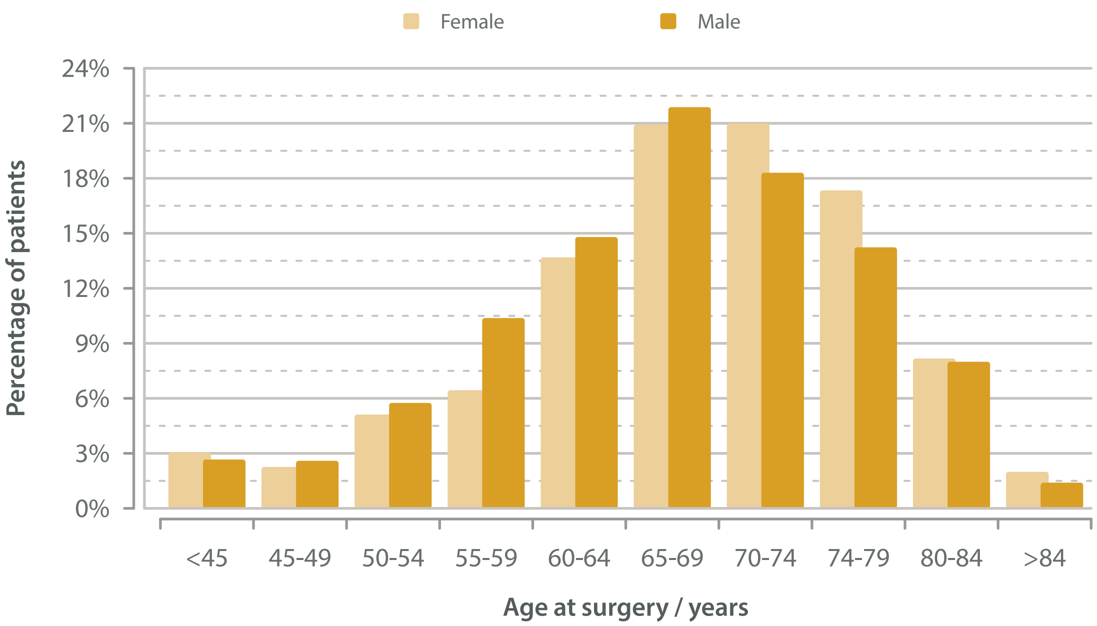
The basic principles applied when preparing graphs for this Third National Thoracic Surgery Activity & Outcomes Report were based, as far as possible, upon William S Cleveland's book *The elements of graphing data* [1]. This book details both best practice and the theoretical bases that underlie these practices, demonstrating that there are sound, scientific reasons for plotting charts in particular ways.

Counts: The counts (shown in parentheses at the end of each graph's title as n=) associated with each graph can be affected by a number of independent factors and will therefore vary from chapter to chapter and from page to page. Most obviously, many of the charts in this report are graphic representations of results for a particular group (or subset) extracted from the database, such as open surgery. This clearly restricts the total number of database-entries available for any such analysis.

In addition to this, some entries within the group under consideration have data missing in one or more of the database questions under examination (reported as unspecified in the tables); all entries with missing data are excluded from the analysis used to generate the graph because they do not add any useful information.

For example, in the graph below, only the database entries where the patient is having a primary resection for lung cancer and both the patient's age and gender are known are included in the analysis; this comes to 2,931 patient-entries (any entries with unspecified age or gender data would have been excluded from the chart).

Fig. 3.01 **Primary resections for lung cancer: Age & gender (n=2,931)**



Confidence interval: In the charts prepared for this report, most of the bars plotted around rates (percentage values) represent 95% confidence intervals [2]. The width of the confidence interval provides some idea of how certain we can be about the calculated rate of an event or occurrence. If the intervals around two rates do not overlap, then we can say, with the specified level of confidence, that these rates are different; however, if the bars do overlap, we cannot make such an assertion.

Bars around averaged values (such as patients' age, post-operative length-of-stay, *etc.*) are classical standard error bars or 95% confidence intervals; they give some idea of the spread of the data around the calculated average. In some analyses that employ these error bars there may be insufficient data to legitimately calculate the standard error around the average for each sub-group under analysis; rather than entirely exclude these low-volume sub-groups from the chart their arithmetic average would be plotted without error bars. Such averages without error bars are valid in the sense that they truly represent the data submitted; however, they should not to be taken as definitive and therefore it is recommended that such values are viewed with extra caution.

1. Cleveland WS. *The elements of graphing data*. 1985, 1994. Hobart Press, Summit, New Jersey, USA.
2. Wilson EB. Probable inference, the law of succession, and statistical inference. *Journal of American Statistical Association*. 1927; **22**: 209-212.

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Section 1

The Thoracic Surgical Register

Chapter 1: An overview of activity in the SCTS Thoracic Register

Introduction

The Society for Cardiothoracic Surgery's Thoracic Register project has been collecting data since 1980, making it the longest running national register of general thoracic surgery in the world. The structure has remained straightforward, recording the number of operations performed and in-hospital mortality for individual hospitals and later trusts. This simple structure may have helped its longevity. We aim to collect data from all public sector hospitals providing adult general thoracic surgical services in the United Kingdom and the Republic of Ireland. In recent years we have also welcomed returns from private hospitals that provide adult thoracic surgery.

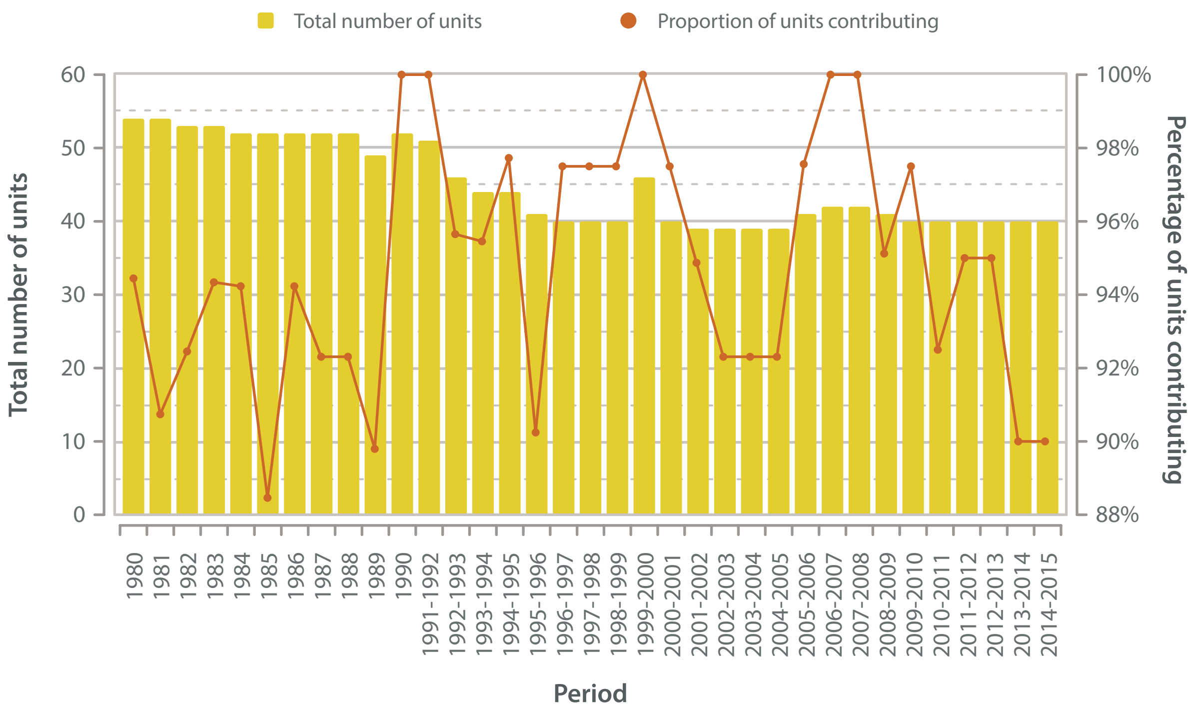
Data collection and completeness

The project's design is simple, with a data template circulated to unit audit leads several months after the end of the audit year. Leads are asked to list the number of cases performed, and the number of inpatient deaths for each of the operation types listed. The Society uses a self-developed classification, which has not changed since our last report in 2011. A copy of these case definitions and our guidance to audit leads can be found in Appendix 2 and Appendix 3 (page 126). For a list of our current audit leads see page 124.

The thoracic register has enjoyed high levels of data submission since its inception 35 years ago (Fig. 1.02). In the 2010-2015 we have received annual returns from all NHS units in Great Britain & Northern Ireland, although some public hospitals in the Republic of Ireland have not submitted returns every year.

Fig. 1.02

Number of units in the United Kingdom & Ireland and rates of submission to the Thoracic Surgery Register; 1980-2015



There has been a process of centralisation since 1980, when 54 units were active in Great Britain & Ireland. By 2015 this had reduced to 40, including the Royal Brompton and Harefield NHS Trust, which provides services at two hospital sites in Greater London. Between 2010 and 2015, only the unit at King's College Hospital ceased lung cancer surgery, but continues to perform other forms of thoracic surgery. Since 2015, the Royal Devon and Exeter NHS Foundation Trust has ceased providing thoracic surgical services.

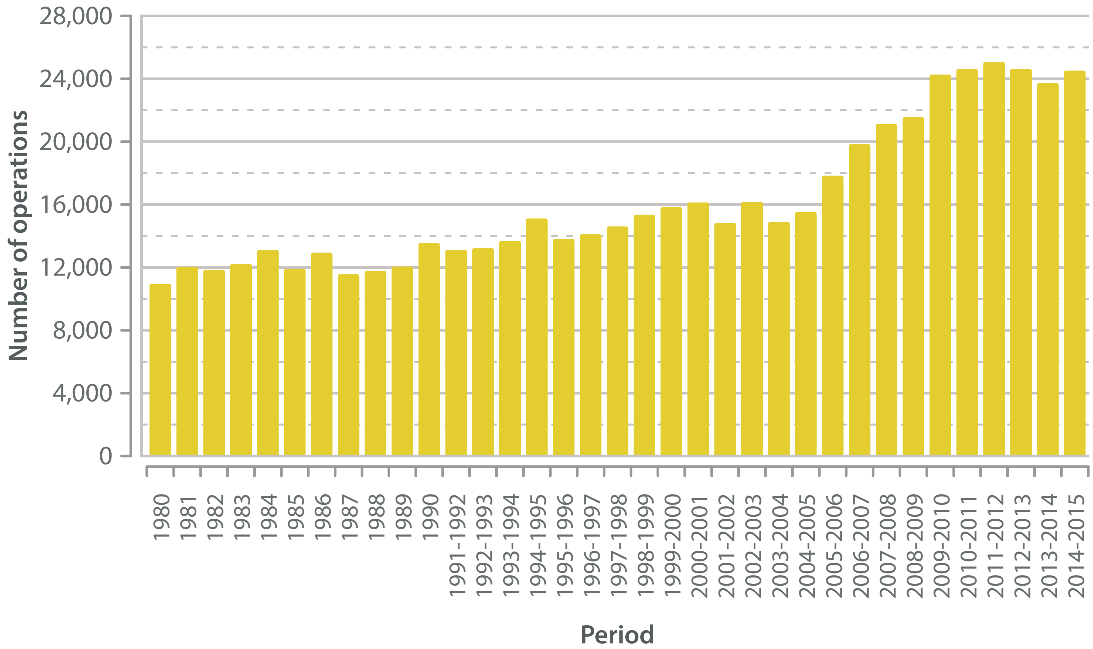
In 2014-2015, following an initiative from the surgical team at Papworth Hospital, we received our first return from an independent hospital, Spire Cambridge. We are keen to see more reporting of results from the private sector, as significant amounts of publicly-funded activity takes place in these hospitals.

Activity

There continues to be an expansion in lung cancer resection, which has continued since our last report in 2011 (see section 1 chapter 2). However, overall thoracic surgical activity has been broadly static at just under 25,000 cases / year since 2009-2010 (Fig. 1.03).

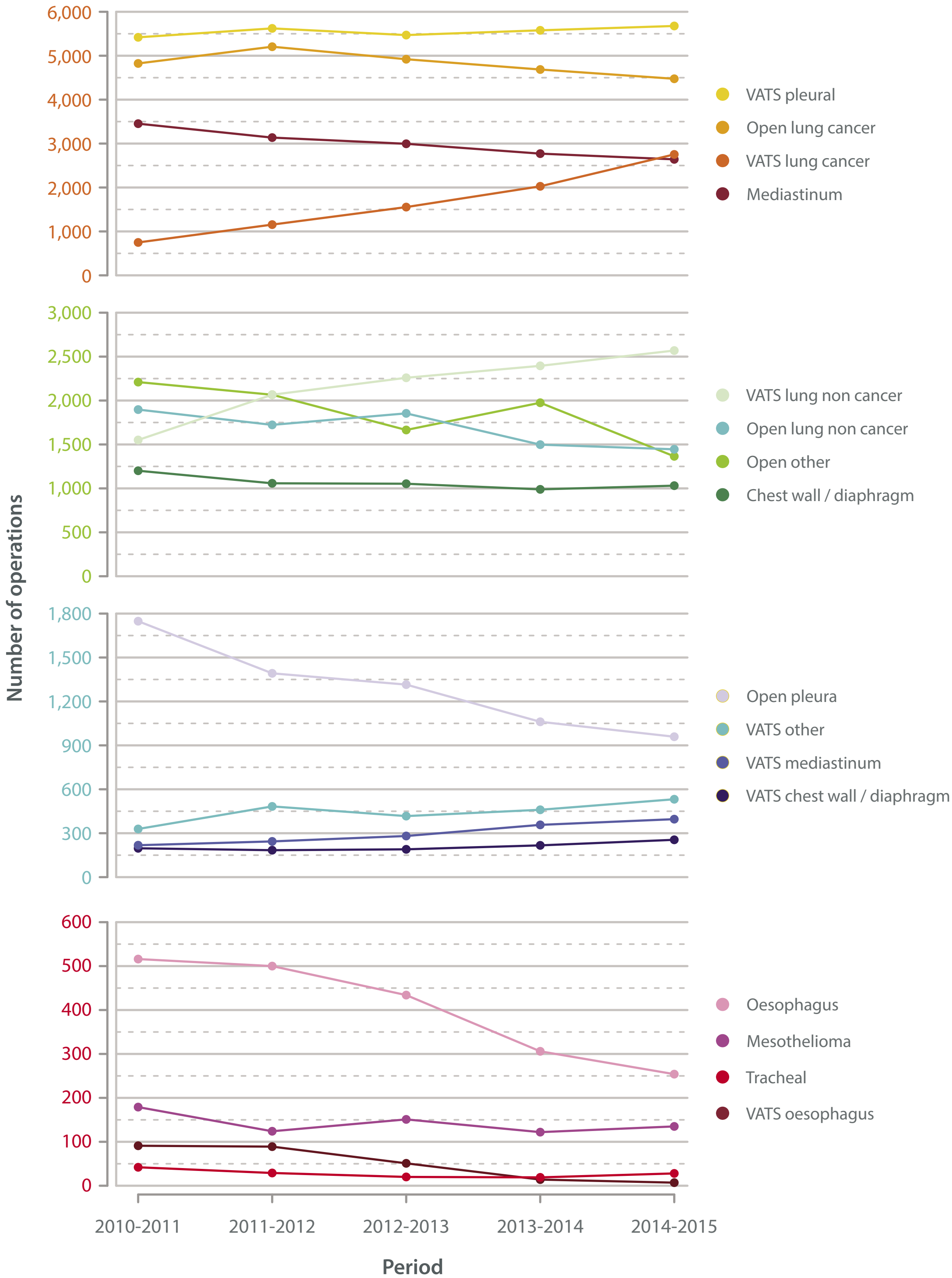
Fig. 1.03

The Thoracic Surgical Register: All activity excluding endoscopy; 1980-2015 (n=567,621)



Within this headline figure there have been major changes in the surgery being performed. VATS surgery for cancer has almost trebled, while open lung cancer resection and mediastinal surgery groups (largely made up of mediastinoscopy biopsy procedures) both registered falls. Throughout this period VATS pleural surgery, a classification that includes biopsy procedures, pleural sepsis and pneumothorax surgery, has remained the largest procedure group by number of cases (Fig. 1.04).

Fig. 1.04 **Changes in activity *per* procedure group; 2010-2015 (123,326)**



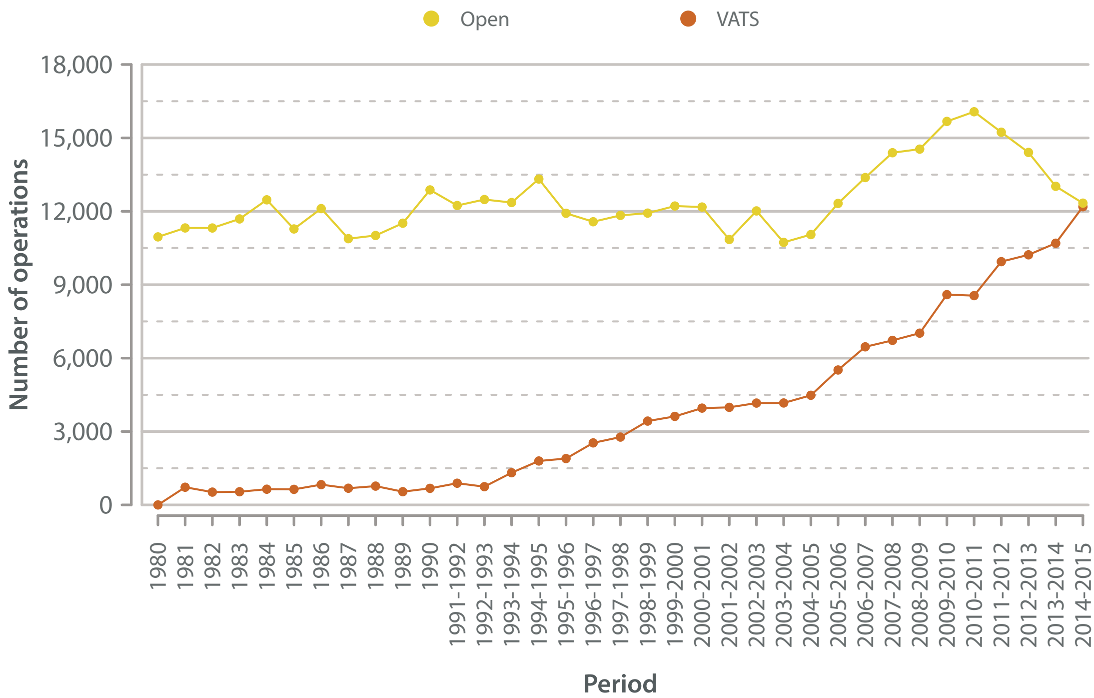
Changing patterns of activity have highlighted the need to update our procedure classification, which has remained unchanged for several years. For example, in 2010-2015 it was not possible to differentiate between VATS segmentectomy and wedge procedures, to report robotics procedures or to specifically code for emerging procedures such as internal fixation following chest trauma. To address this, we updated our template in 2015-2016 to standardise definitions across open and thoracoscopic surgery, and to sub-classify some expanding procedure groups.

Table 1.02 **Thoracic Surgery Register:** recent changes in activity for each procedure group

		Period				
		2010-11	2011-12	2012-13	2013-14	2014-15
Procedure	VATS pleural	5,419	5,622	5,470	5,578	5,677
	Open lung cancer	4,824	5,205	4,920	4,686	4,475
	VATS lung cancer	749	1,155	1,554	2,027	2,753
	Mediastinum	3,453	3,136	2,995	2,771	2,641
	VATS lung non cancer	1,551	2,066	2,259	2,395	2,569
	Open lung non cancer	1,897	1,723	1,854	1,498	1,445
	Open other	2,210	2,066	1,665	1,975	1,365
	Chest wall / diaphragm	1,201	1,058	1,053	989	1,031
	Open pleura	1,748	1,392	1,315	1,061	959
	VATS other	329	483	417	460	532
	VATS mediastinum	218	244	281	357	396
	VATS chest wall / diaphragm	197	184	190	217	255
	Oesophagus	516	500	434	306	254
	Mesothelioma	179	124	151	122	135
	Tracheal	42	29	20	19	28
	VATS oesophagus	91	89	51	14	7

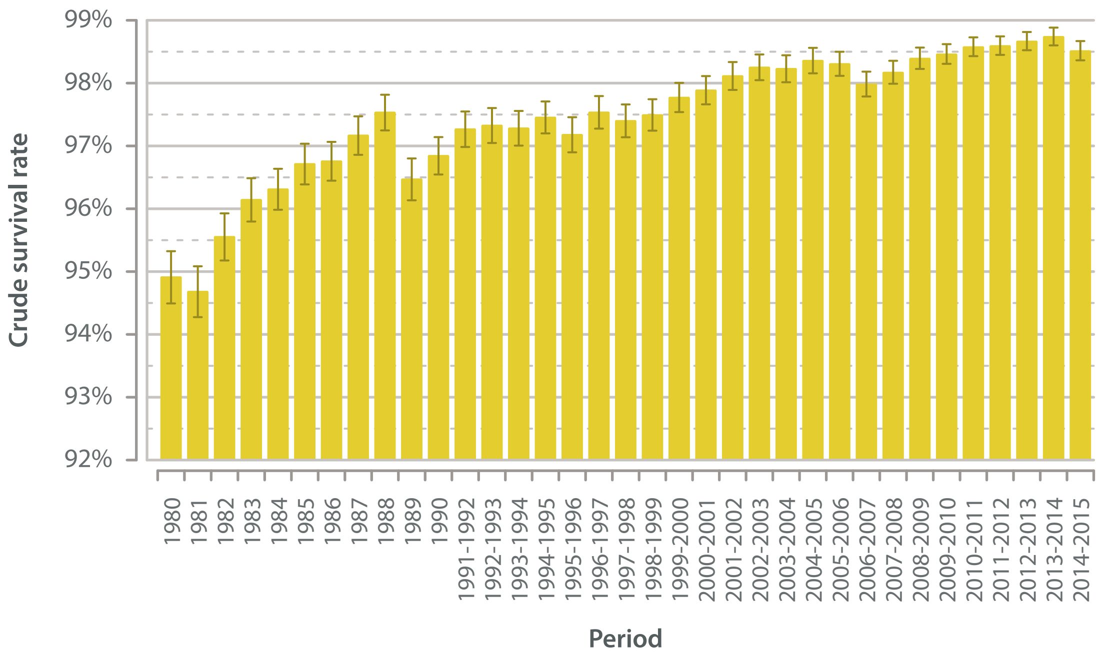
We have seen a progressive move towards VATS approaches across most procedure groups, which together accounted for nearly half of all surgery performed in 2015 (Fig. 1.05).

Fig. 1.05 **Open compared to VATS activity; 1980-2015 (n=435,487)**



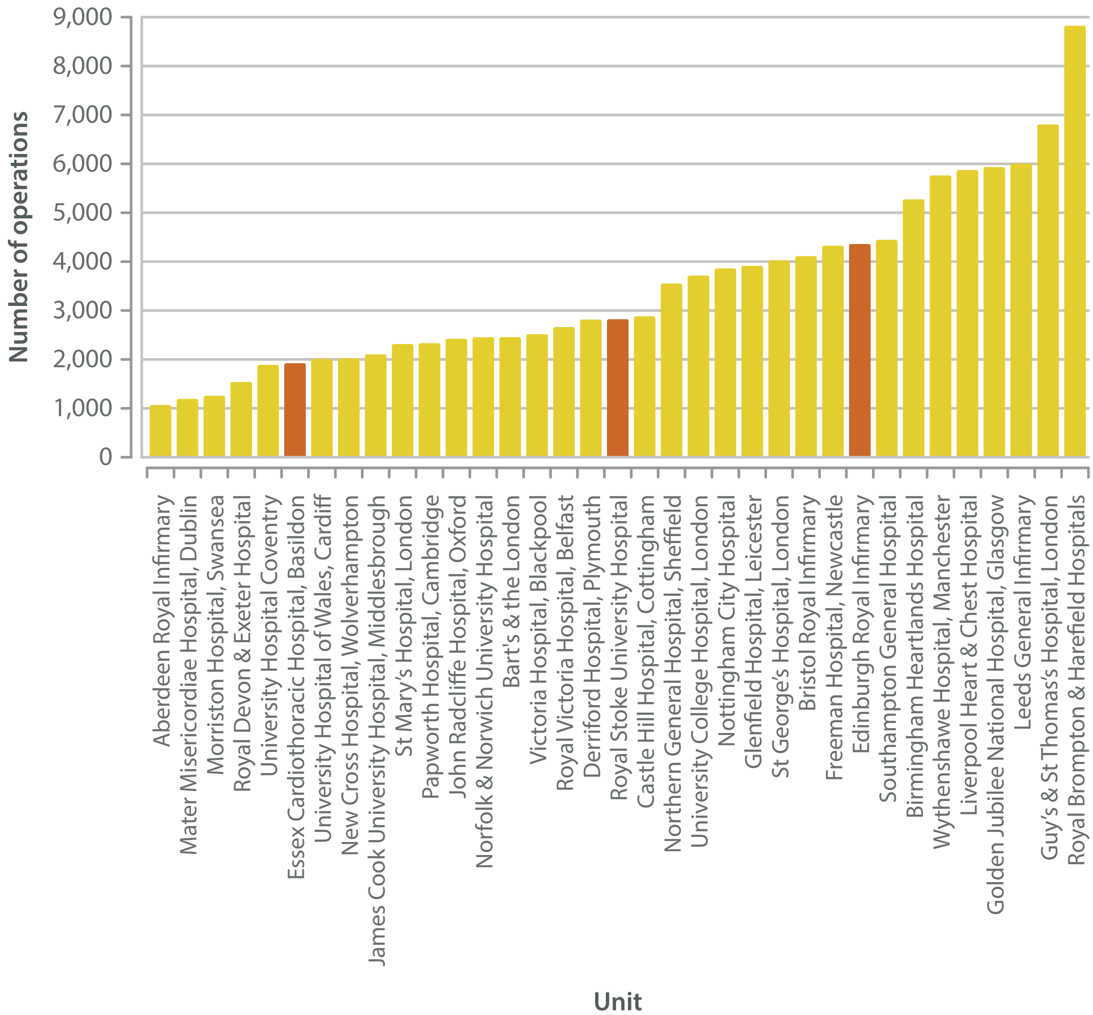
Whole-registry survival has risen from around 95% in 1980 to around 98.5% today (Fig. 1.06). We explore survival rates for individual procedures in subsequent chapters.

Fig. 1.06 **All activity excluding endoscopy: Survival rates; 1980-2015 (n= 568,382)**



Units of various sizes exist around the country (Fig. 1.07). With a median unit activity of 565 cases / year between 2010-2015 (inter-quartile range 383-869), there is an eight-fold difference between the smallest and largest hospitals or trusts (213 *versus* 1,764 cases / year).

Fig. 1.07 **All activity excluding endoscopy: Activity for each unit; 2010-2015 (n= 121,479)**



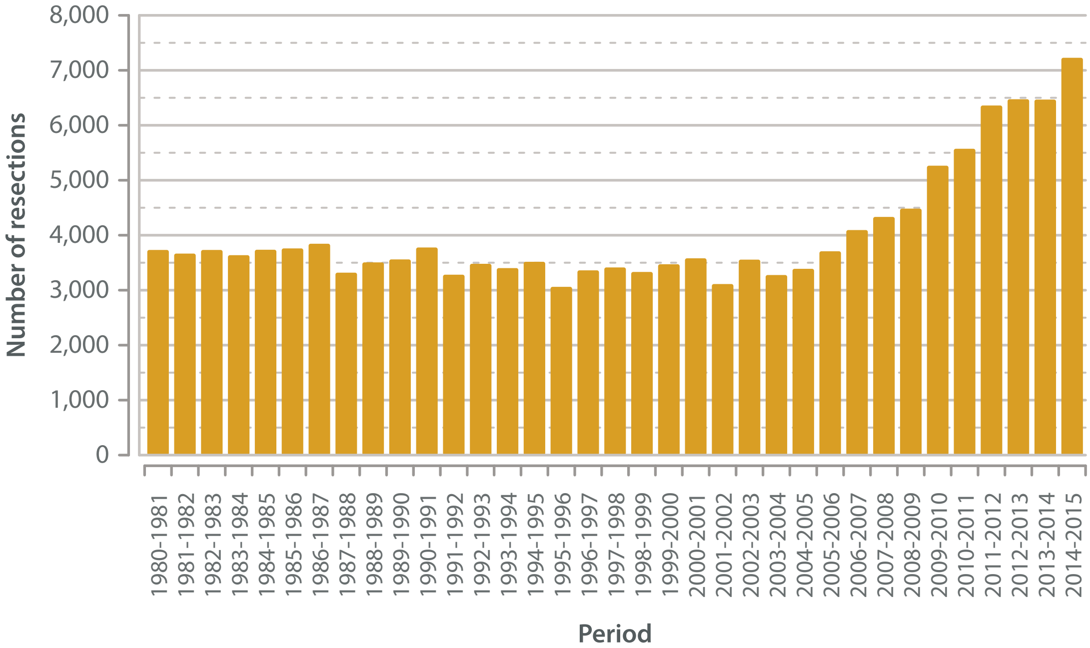
Chapter 2: Surgery for primary lung cancer

Activity and survival trends

Resection of primary lung cancer accounts for a major part of the work of thoracic surgeons. During the 35 years of the thoracic registry, 141,491 lung resections or attempted resections have been performed. From 1980 until the mid-2000s activity was remarkably static at between 3,000-4,000 cases *per* year. Activity then began to rise, and has continued to do so (Fig. 2.01). In 2014-2015, 7,228 cases were reported, more than double the median figures for the years 1980 to 2005.

Fig. 2.01

Surgery for primary lung cancer: All resections for primary lung cancer; 1980-2015 (n=141,491)



A joint report from the SCTS and the British Thoracic Society at that time (https://scts.org/wp-content/uploads/2016/10/Under_provision_of_thoracic_surgery.pdf) highlighted the under-provision of British lung cancer surgery relative to similar European countries. An increase in recruitment to the subspecialty and NHS funding changes led to a significant increase in activity. An associated increase in resection rates (from 8% in England 2005 to 16% in 2015) has been documented in the National Lung Cancer audit (see https://www.rcplondon.ac.uk/projects/national-lung-cancer-audit). This increase in activity has been a significant achievement for British and Irish thoracic surgery.

The risk of in-hospital mortality following lung resection has fallen progressively since 1980, from more than 5% before 1985 to below 2% in the last four years reported here (Fig. 2.02). There have been improvements in both pneumonectomy and lobectomy survival (Fig. 2.03).

Fig. 2.02

Surgery for primary lung cancer: Survival to discharge after resection for primary lung cancer; 1980-2015 (n=137,577)

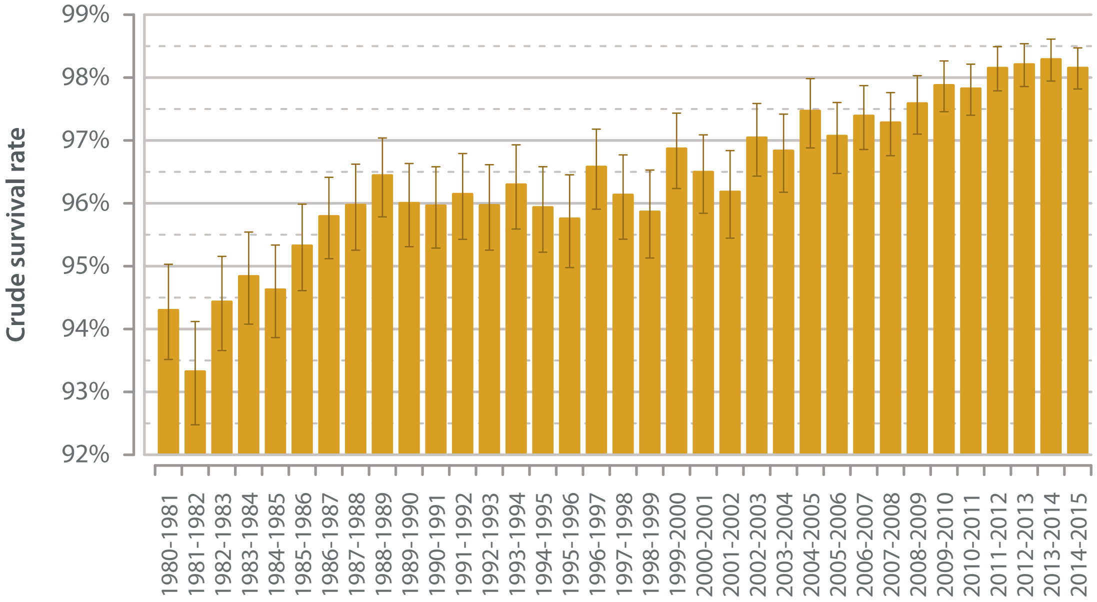
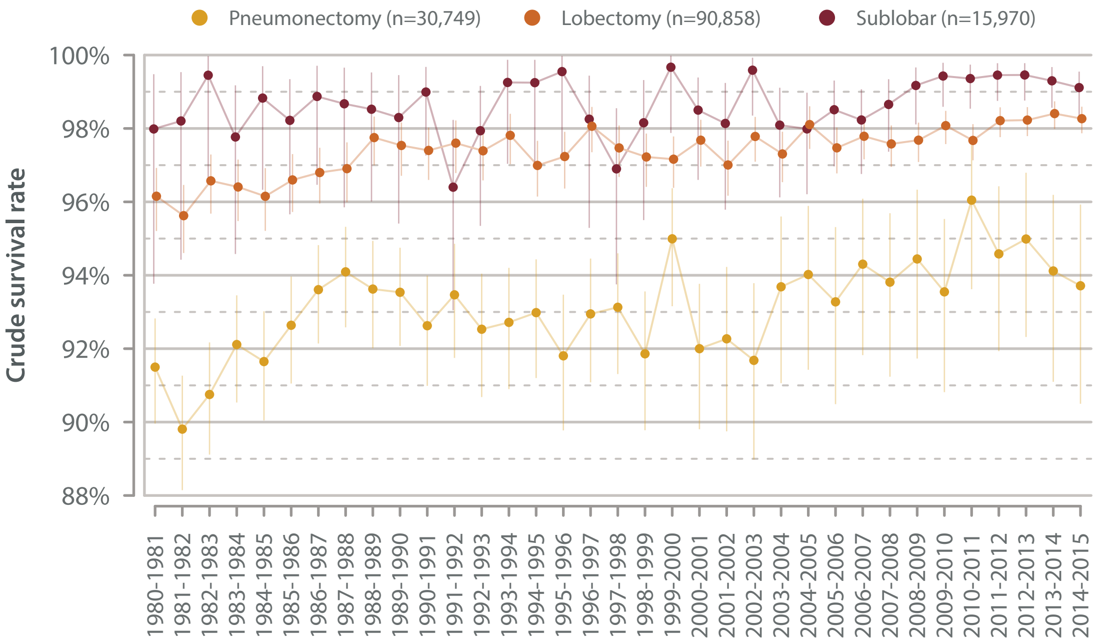


Fig. 2.03

Surgery for primary lung cancer: Survival to discharge according to the type of resection; 1980-2015



In addition, a reduction in the number of pneumonectomies and a move to lobectomy procedures, which have a lower operative risk, may have contributed to the overall reduction in mortality risk. To illustrate this improvement, if the mortality rates and ratios seen in 1980 had remained the same, we would have expected 386 deaths in 2015. In the event only 124 patients died, a relative risk reduction of over 67%.

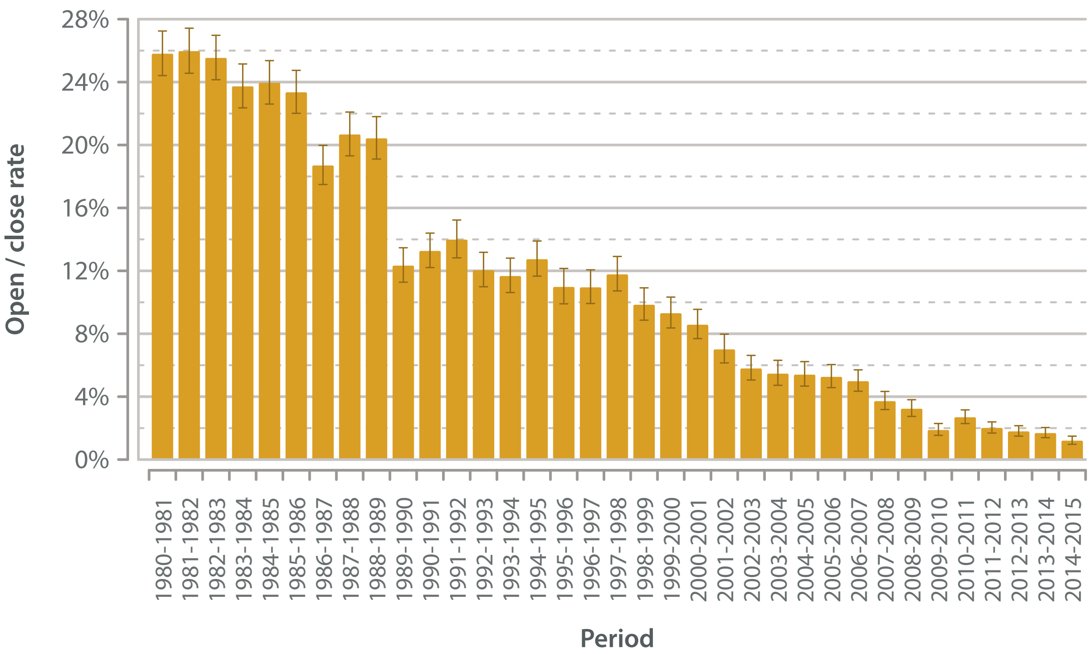
Although we have seen lower mortality in lobectomy operations compared to pneumonectomies, it is important to remember that the register does not allow us to make any adjustment for differences in fitness or comorbidity. It is likely that patients undergoing more extensive lung resections had more advanced tumours, and may have had other systematic differences from those having less extensive resections.

The low in-hospital mortality seen in sublobar excisions is interesting. Since 2008-2009 this has remained below 1%. Although we do no have comorbidity data, current BTS / SCTS guidance suggests that sublobar operations should usually be reserved for patients felt to be at prohibitively high risk for lobectomy [1]. It is notable that the actual mortality in this presumably high morbidity patient group is consistently so low.

There were at least three important changes in the pattern of lung resection during this time suggesting improvements in the quality of care. Firstly, the risk of undergoing exploratory surgery without lung resection, also known as *open and close* or *futile thoracotomy*, has fallen from over a quarter of all patients in 1980 to less than one in fifty in 2015 (Fig. 2.04). This major improvement may be attributed in part to improvements in pre-operative staging, since this period includes the adoption of routine pre-operative CT scanning and later PET scanning, increased use of staging mediastinoscopy and the advent of endobronchial ultrasound transbronchial biopsy (EBUS). Access to thoracoscopy may also have played its part, since an exploratory or staging VATS procedure that did not proceed to a lung resection is not recorded in the registry.

Fig. 2.04

Surgery for primary lung cancer: Open / close thoracotomy rate for all attempted resections; 1980-2015 (n=141,491)

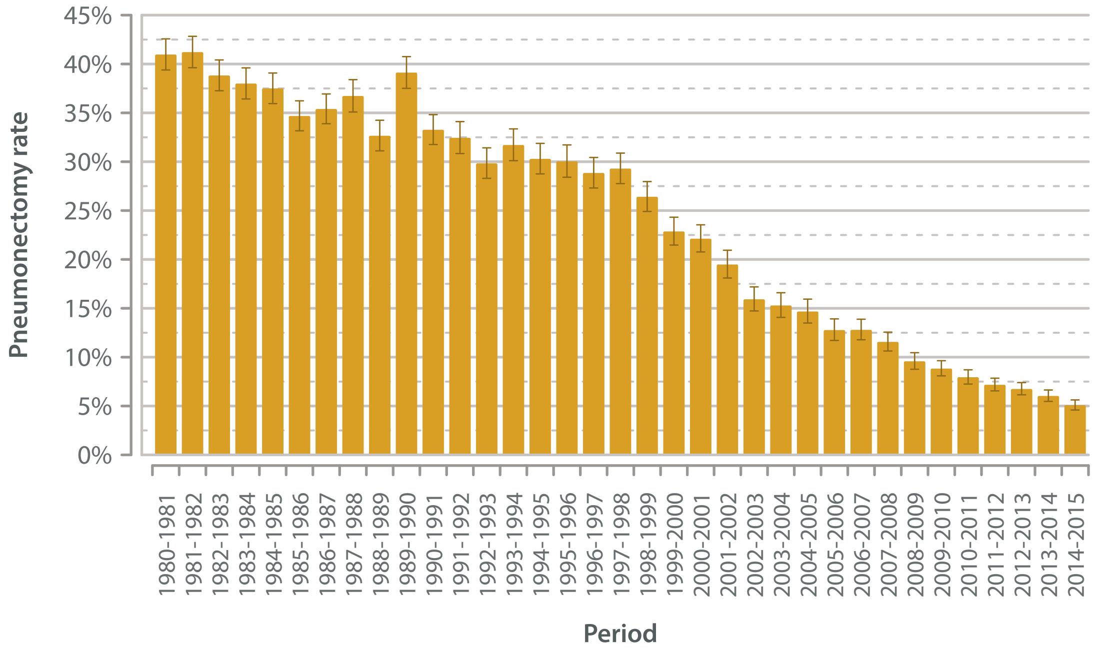


Pneumonectomy

Secondly, the proportion of patients undergoing a pneumonectomy has fallen markedly, from around 40% in 1980 to around 5% today (Fig. 2.05). Given the higher peri-operative mortality following pneumonectomy, this is a very welcome improvement. It has come about during an era of increasing resection rates, suggesting that this is a genuine improvement rather than due to risk avoidance. In contrast, 79% of cancer resections in 2014-2015 were by lobectomy, up from only 55% in 1980 (Fig. 2.06). The bulk of the increase in resections seen since the mid 1990s is attributable to an increase in lobectomy activity. Interestingly, the sleeve resection rate as a proportion of all resections has remained static during this period (Fig. 2.07). This suggests that patients previously treated by pneumonectomy are now undergoing lobectomy or sublobar excisions, since both of these categories grew markedly. Lung resections with chest wall and diaphragm as a proportion of all resections have also remained largely static (Fig. 2.08).

Fig. 2.05

Surgery for primary lung cancer: Pneumonectomy rate for all attempted resections; 1980-2015 (n=139,850)



Surgery for primary lung cancer

Fig. 2.06

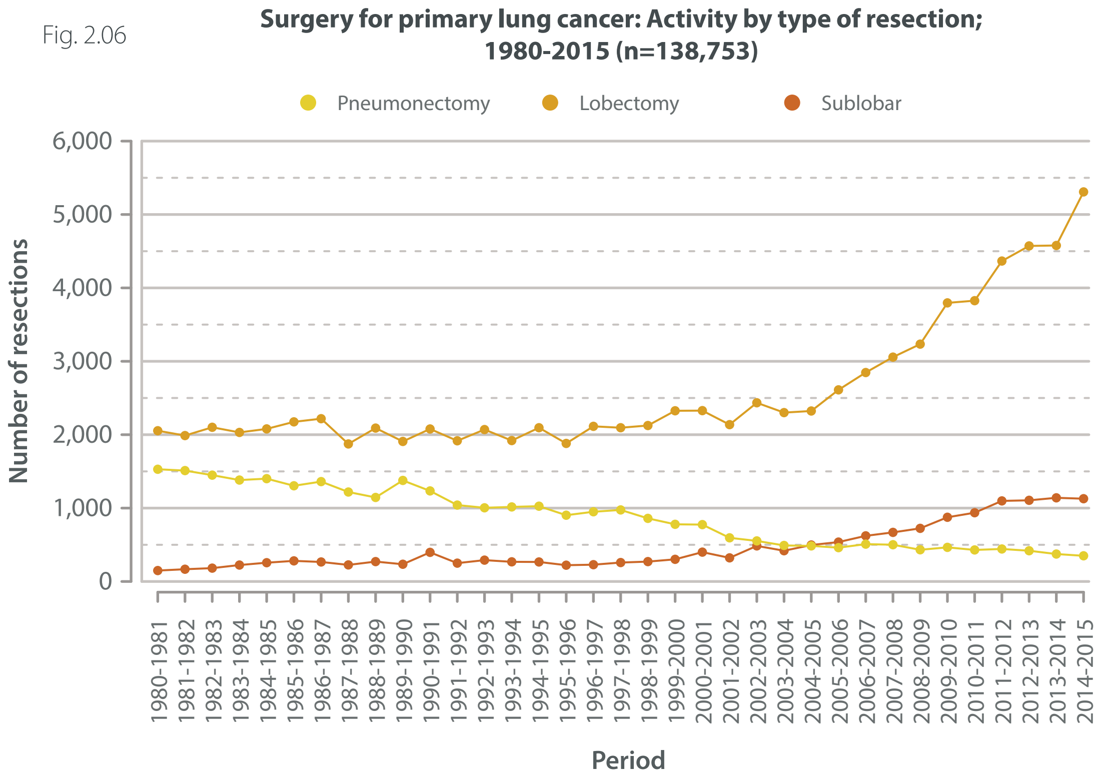


Fig. 2.07

Surgery for primary lung cancer: Sleeve lobectomy rate for all attempted resections; 1980-2015 (n=106,917)

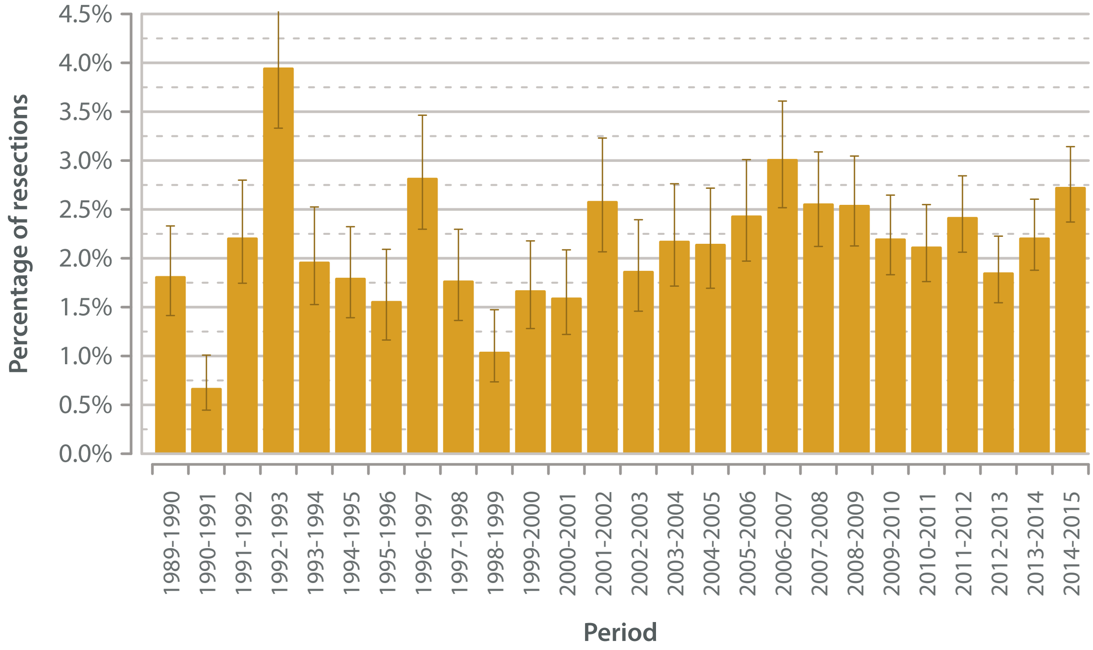
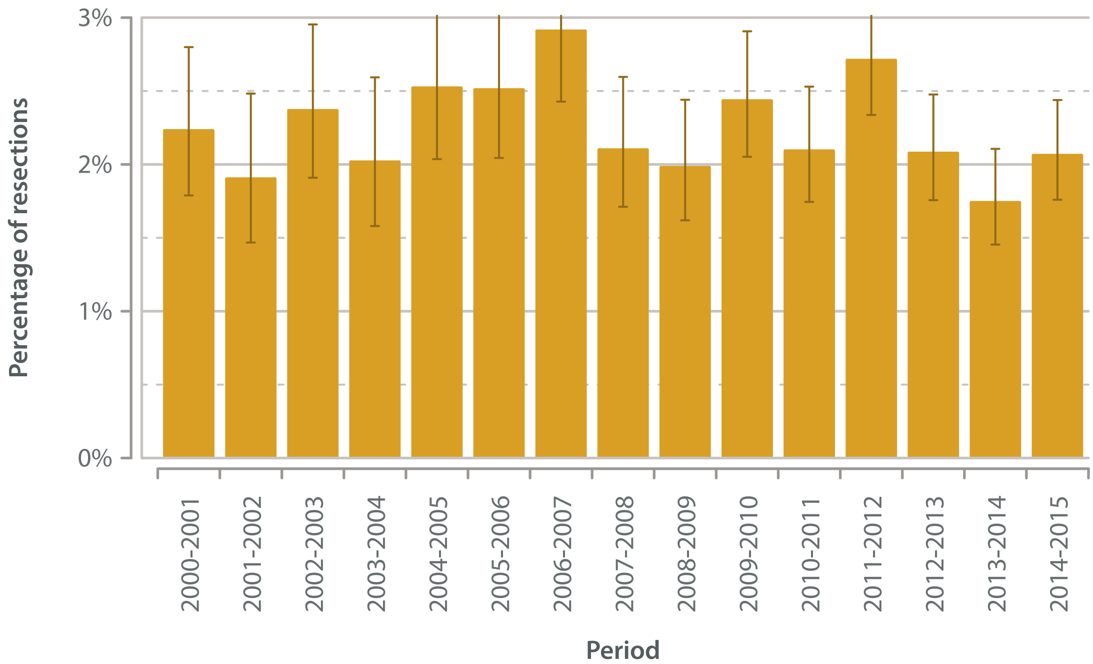


Fig. 2.08

Surgery for primary lung cancer: Lung resection with chest wall or diaphragm rate for all attempted resections; 2000-2015 (n=70,234)

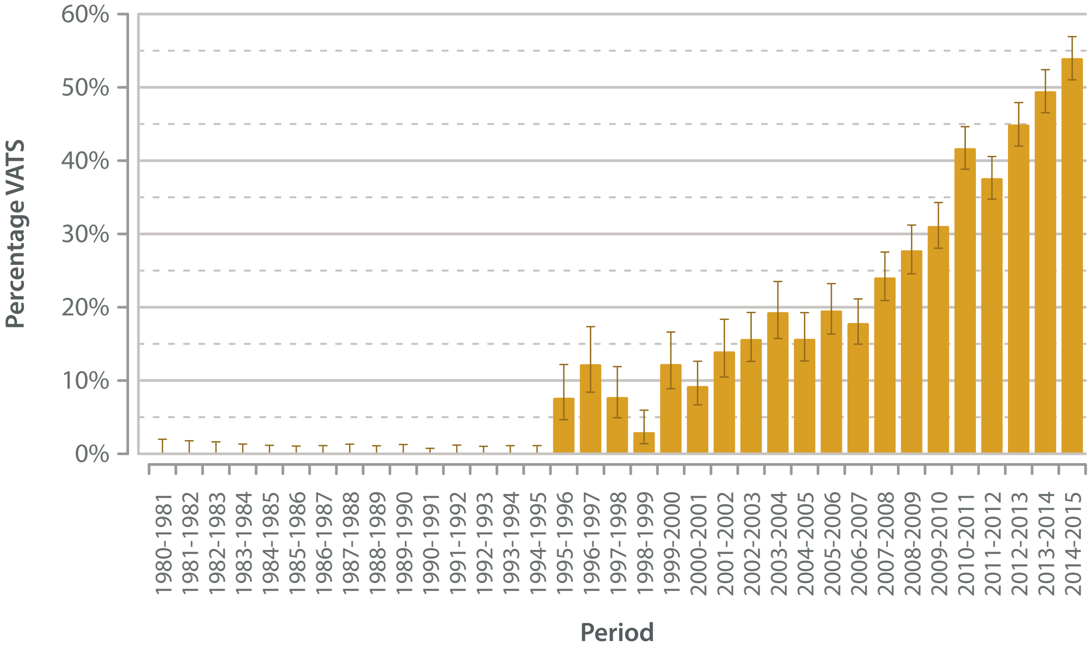


Thoracoscopic (VATS) surgery

The third trend we observed was the widespread adoption of thoracoscopic or VATS techniques. We began to track VATS resections in the mid-1990s. Adoption was faster in sublobar resections, with around 10% of these being done by VATS by the millennium, and over 50% by 2015 (Fig. 2.09). During this time we did not differentiate between non-anatomical *wedge* resections and technically more demanding *segmentectomy* operations, where the blood vessels, airway and lymph nodes of a segment are dissected individually. It is quite likely that the early adoption of VATS approaches for sublobar resections was for technically easier wedge procedures. These two operations have now been subdivided in the returns.

Fig. 2.09

Surgery for primary lung cancer: VATS rate for all sublobar excisions 1980-2015 (n=16,172)



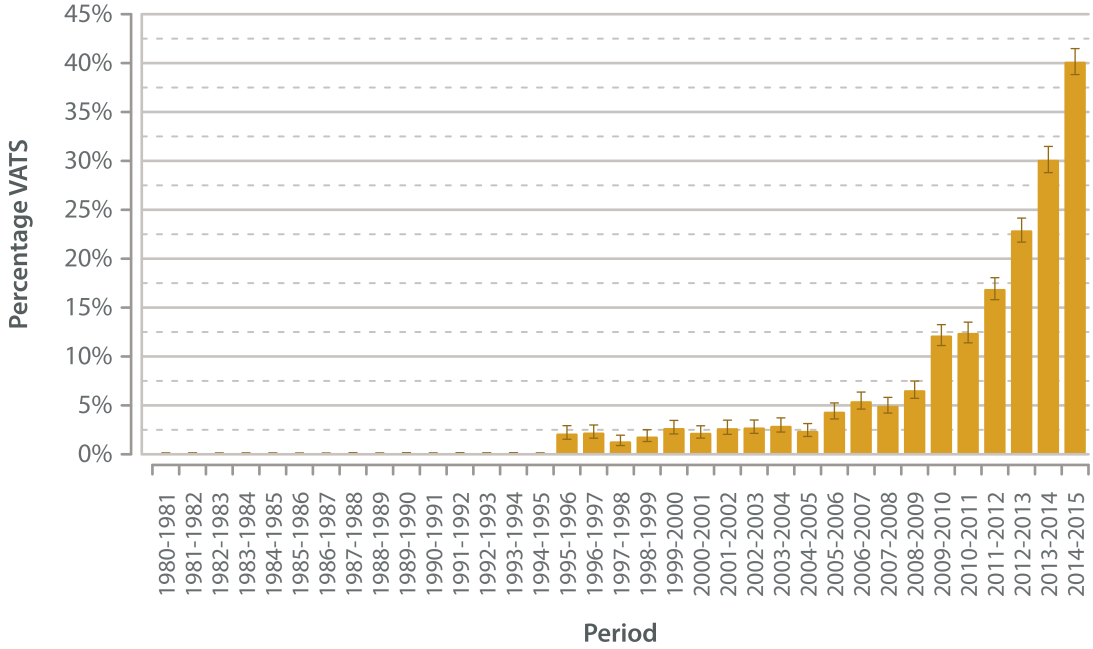
VATS approaches for lobectomy and bilobectomy were adopted later, with the 10% threshold being crossed in 2009-2010, around a decade later than for sublobar excisions (Fig. 2.10). These operations involve dissection of blood vessels and other hilar structures, and this greater technical complexity probably explains their slower adoption. VATS lobectomy comprised 40% of all cancer resections in 2015, making it the second most common operation after open lobectomy.

VATS pneumonectomy cases have been reported for several years, but in very small numbers. In the five years 2010-2015 they comprised less than 2% of all pneumonectomies and 0.1% of all cancer resections.

Surgery for primary lung cancer

Fig. 2.10

Surgery for primary lung cancer: VATS rate for all isolated lobectomies and bilobectomies; 1980-2015 (n=89,254)



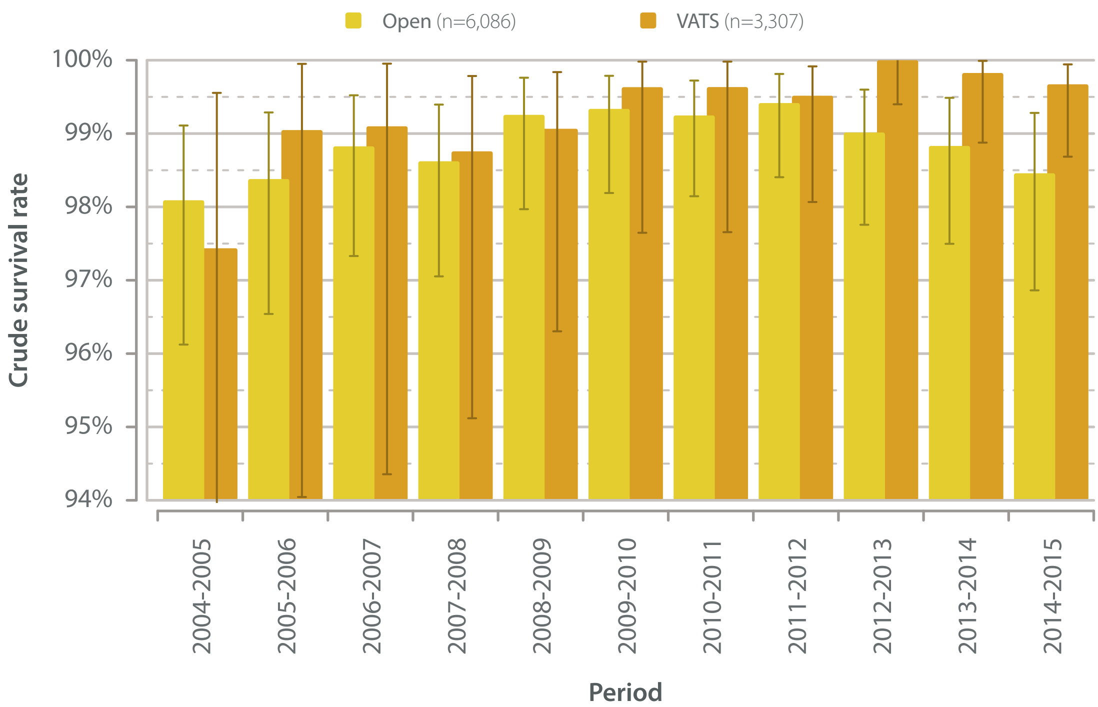
Since 2010, VATS lobectomy in hospital survival has been relatively constant at around 99%. Open lobectomy survival has been consistently around 98% (Fig. 2.11).

Fig. 2.11

Surgery for primary lung cancer: Survival to discharge after lobectomy according to approach; 2004-2015

The survival after open and VATS sublobar resections is less clear, with both approaches associated with high survival rates. It is reassuring that in hospital survival after sublobar resection has been consistently greater than 98% for ten years (Fig. 2.12).

Fig. 2.12 **Surgery for primary lung cancer: Survival to discharge after sublobar resection according to approach; 2004-2015**



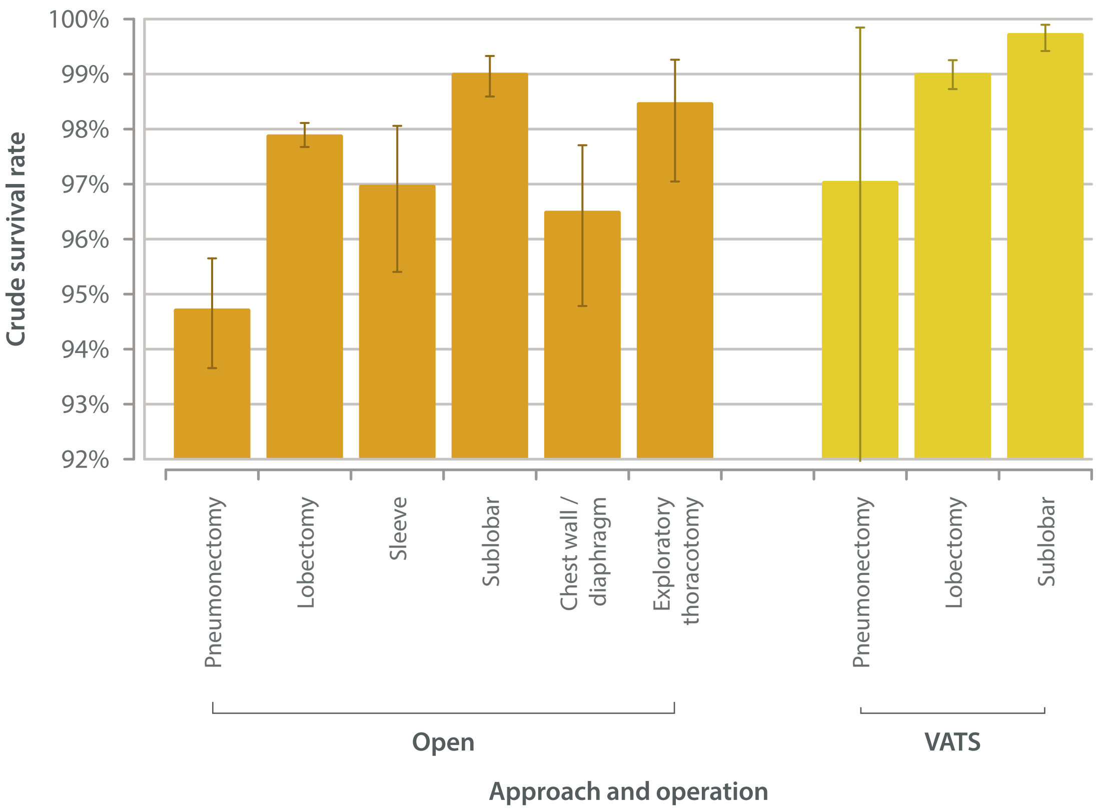
Great caution must be exercised in interpreting these results on their own, as we do not have important data on potential confounding variables such as tumour stage and comorbidity. There may be systematic differences between the patient groups offered open and VATS surgery, which account for the difference seen in in-hospital survival.

The pooled survival for individual lung resections and approaches from 2010-2015 and the source data is shown in Fig. 2.13 and Table 2.01.

Table 2.01 **Surgery for primary lung cancer:** in-hospital outcome and operation

Approach and operation		In-hospital outcome			
		Survival	Deaths	All	Survival rate
Open	Pneumonectomy [i]	1,927	107	**2,034**	94.7%
Open	Lobectomy [ii]	16,628	356	**16,984**	97.9%
Open	Sleeve lobectomy	709	22	**731**	97.0%
Open	Sublobar	3,046	30	**3,076**	99.0%
Open	Any resection with chest wall / diaphragm	665	24	**689**	96.5%
Open	Exploratory thoracotomy; no resection	587	9	**596**	98.5%
VATS	Pneumonectomy	33	1	**34**	97.1%
VATS	Lobectomy	5,781	57	**5,838**	99.0%
VATS	Sublobar	2,360	6	**2,366**	99.7%

Fig. 2.13 **Surgery for primary lung cancer: Survival to discharge and procedure; 2010-2015**



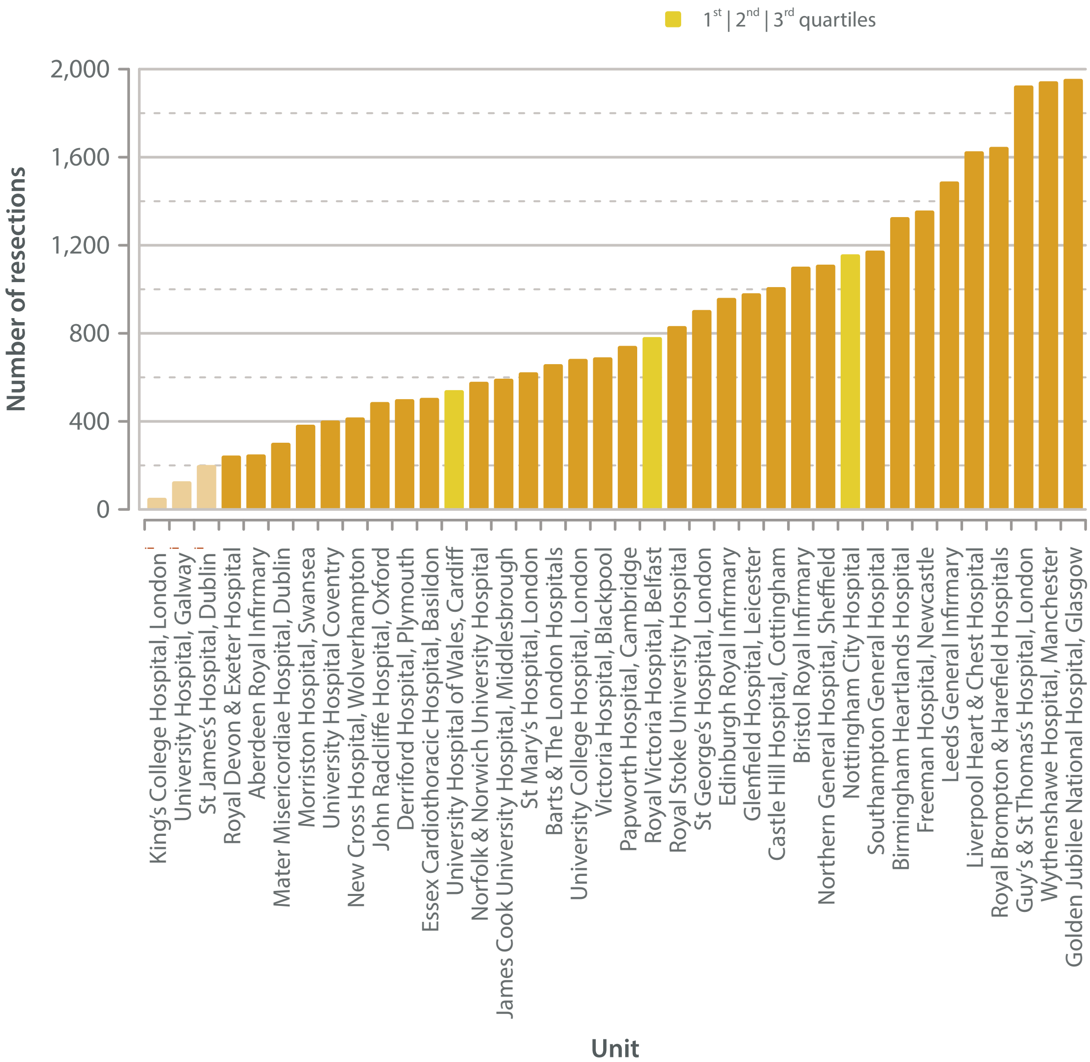
i. Includes open sleeve pneumonectomy.

ii. Includes bilobectomies.

Unit level activity 2010-2015

There is marked variation in the size of surgical units, judged by their total lung cancer resection activity over the 2010-2015 period (Fig. 2.14). The smallest unit for which we have five complete years of data (Exeter with 245 cases) is nearly a tenth the size of the largest (the Golden Jubilee Glasgow with 1,956 cases). After excluding the five units who did not submit five full years of data, the median unit activity was 783 cases over five years (IQR 524-1,167). This equates to a median unit activity of 157 cases / year.

Fig. 2.14 **Surgery for primary lung cancer: Resections *per* unit; 2010-2015 (n=32,203)**

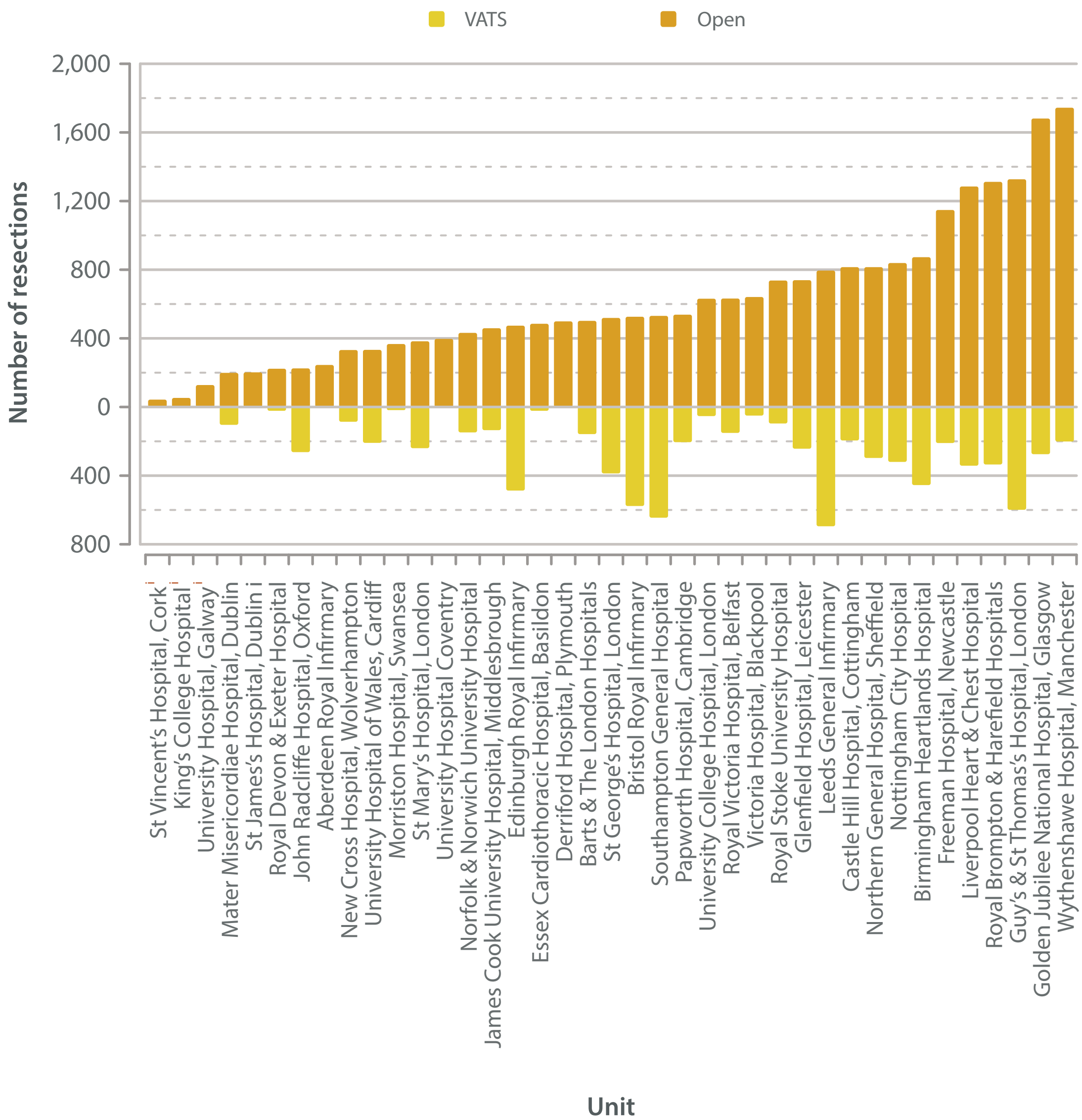


There is some variation in the surgical approach used (Fig. 2.15), and in the procedures performed (Fig. 2.16). Individual unit VATS rates ranged from 0% to 54.8% of all cases with a pooled national rate of 25.5%. The pneumonectomy rate varies from 0.8%-12.8% with a pooled national rate of 6.4%, and the sublobar operation rate varied from 2.9% to 34.5%, with a pooled national rate of 16.8%.

i. Centres did not submit data for every year in the defined analysis period.

Fig. 2.15

Surgery for primary lung cancer: Resections *per* unit according to surgical approach; 2010-2015

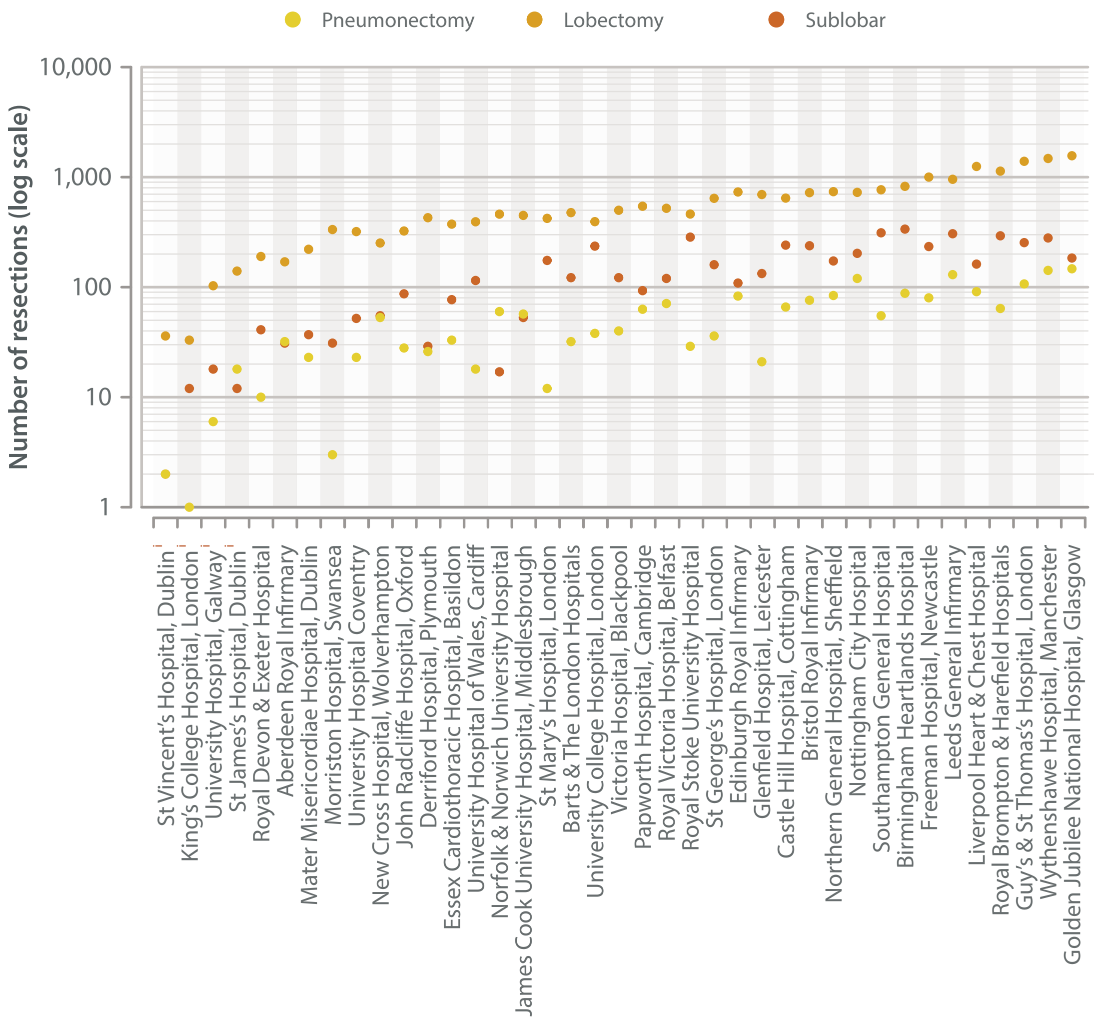


i. Centres did not submit data for every year in the defined analysis period.

Surgery for primary lung cancer

Fig. 2.16

Surgery for primary lung cancer: Operation performed for at each unit; 2010-2015 (n=30,330)



i. Centres did not submit data for every year in the defined analysis period.

References

1. Lim E, Baldwin D, Beckles M, Duffy J, Entwisle J, Faivre-Finn C, Kerr K, Macfie A, McGuigan J, Padley S, Popat S, Screaton N, Snee M, Waller D, Warburton C, Win T. Guidelines on the radical management of patients with lung cancer. *Thorax*. 2010; **65**: iii1-iii27.

Chapter 3: Lung resection for conditions other than primary lung cancer

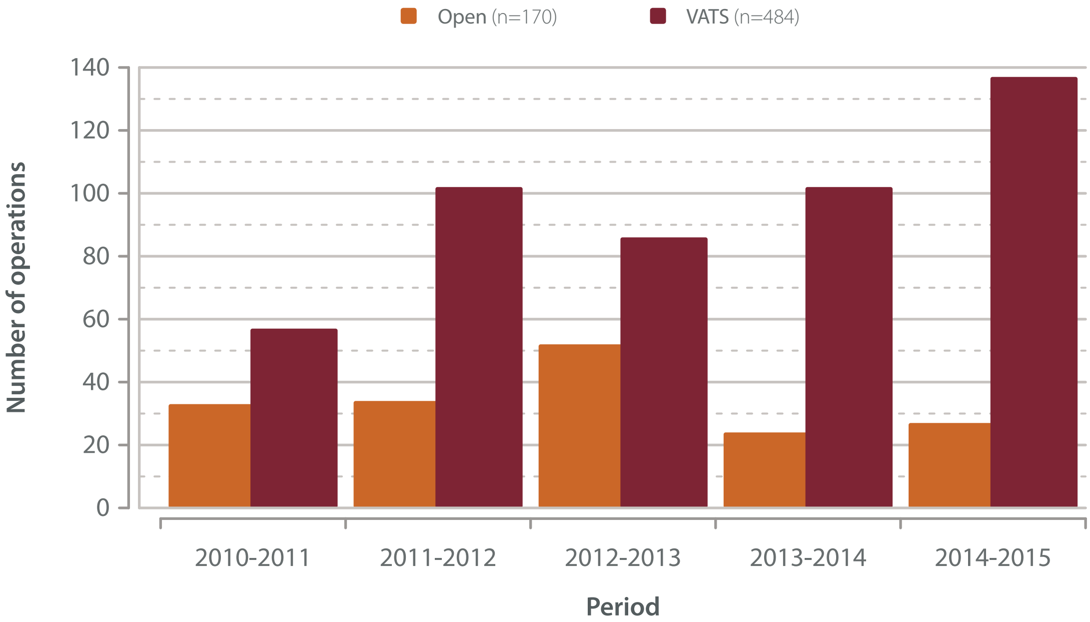
This group comprises a diverse group of patients, procedures and diseases treated. Its analysis is complicated by a lack of data on the indications for surgery, and the exact pathological diagnoses. It includes surgery for major lung infections, for cancers that have spread to the lungs (metastasectomy) and lung biopsy operations for the diagnosis of interstitial lung disease or disseminated malignancy.

Specific data was collected on lung volume reduction surgery *via* both open and VATS approaches, making it possible to analyse these procedures specifically.

Lung volume reduction surgery

Lung volume reduction surgery activity (LVRS) has grown by just over 80% between 2010-2011 and 2014-2015, although absolute numbers remain low at 164 cases in 2014-2015 (Fig. 3.01). This growth was entirely accounted for by an increase in VATS cases. 99% of 484 VATS LVRS patients survived to hospital discharge, as did 96.5% of 170 open LVRS patients (Table 3.01).

Fig. 3.01 **Lung volume reduction surgery: Activity by surgical approach; 2010-2015**



The register did not differentiate between unilateral and bilateral surgery, and did not sub-classify open surgical approaches, for example into thoracotomy or sternotomy approaches. We cannot directly compare the VATS and open outcomes, as we do not have data on the comorbidity of these patient groups. It is possible that patient selection led to systematic differences between the VATS and open groups that we did not capture.

Table 3.01 **Resections for lung conditions other than primary lung cancer:** in-hospital outcome and operation

Approach and operation			In-hospital outcome			
			Survival	**Deaths**	**All**	**Survival rate**
Approach and operation	Open	Pneumonectomy	149	10	**159**	93.7%
		Lobectomy, bilobectomy	2,230	39	**2,269**	98.3%
		Sleeve resection	126	1	**127**	99.2%
		Segmentectomy, wedge	4,908	26	**4,934**	99.5%
		Any resection with chest wall / diaphragm	276	5	**281**	98.2%
		Lung volume reduction	164	6	**170**	96.5%
		Other pulmonary procedure	474	3	**477**	99.4%
	VATS	Wedge; therapeutic	4,163	7	**4,170**	99.8%
		Wedge; diagnostic	4,749	25	**4,774**	99.5%
		Lobectomy	625	1	**626**	99.8%
		Pneumonectomy [i]	12	0	**12**	100.0%
		Bullectomy	772	2	**774**	99.7%
		Lung volume reduction	479	5	**484**	99.0%

i. Note that only 12 VATS pneumonectomies were performed

LVRS activity is concentrated in relatively few centres, with only six units performing more than 25 cases (5 *per year*) in the five years studied (Table 3.02). Most but not all of the larger units performed more VATS than open surgery during this period.

Table 3.02 **Lung volume reduction surgery:** surgical approach per unit; 2010-2015

Unit	Surgical approach: Open	VATS	All
Royal Victoria Hospital, Belfast	11	0	**11**
Birmingham Heartlands Hospital	9	34	**43**
Bristol Royal Infirmary	1	4	**5**
Royal Brompton & Harefield Hospitals	51	47	**98**
University Hospital of Wales, Cardiff	3	4	**7**
University Hospital Coventry	7	0	**7**
Royal Devon & Exeter Hospital	0	6	**6**
Golden Jubilee National Hospital, Glasgow	2	11	**13**
Guy's & St Thomas's Hospital, London	8	10	**18**
Castle Hill Hospital, Cottingham	4	2	**6**
Leeds General Infirmary	2	17	**19**
Glenfield Hospital, Leicester	0	151	**151**
Liverpool Heart & Chest Hospital	17	4	**21**
Wythenshawe Hospital, Manchester	4	2	**6**
Freeman Hospital, Newcastle	1	4	**5**
Nottingham City Hospital	2	31	**33**
John Radcliffe Hospital, Oxford	6	14	**20**
Papworth Hospital, Cambridge	12	46	**58**
Northern General Hospital, Sheffield	8	51	**59**
Southampton General Hospital	0	5	**5**
St George's Hospital, London	1	5	**6**
Royal Stoke University Hospital	3	2	**5**
University College Hospital, London	7	5	**12**
New Cross Hospital, Wolverhampton	2	19	**21**

In 2013 the National Institute for Health and Care Excellence approved endobronchial valves for severe emphysema (IPG465) [1]. These procedures were not tracked by the SCTS during this period, but we are aware of several units who undertake these and similar endobronchial procedures for severe emphysema. These novel therapeutic options for severe emphysema may affect the patterns of referral for surgical LVRS in future.

Lung resections, excluding primary lung cancer and lung volume reduction surgery

Trends in activity between 2010 and 2015 are shown for open surgery, and or VATS procedures in Fig. 3.02. Sublobar excisions account for the majority of procedures performed in this category. Larger resections, and particularly pneumonectomy, are uncommon in this patient group, with only 22 pneumonectomies *via* any approach in this 5-year period. This contrasts with the primary lung cancer resection group, where lobectomies and bilobectomies are the commonest procedure group.

Fig. 3.02 **Lung resection excluding lung volume reduction surgery: Activity; 2010-2015**

National guidance, supported by randomised trial evidence, advocates lobectomy in most primary lung cancer patients who are fit for surgery [2]. No similar guidance exists for other diseases requiring lung resection. The difference in the resections used for lung cancer and other resections probably reflects this difference in the evidence.

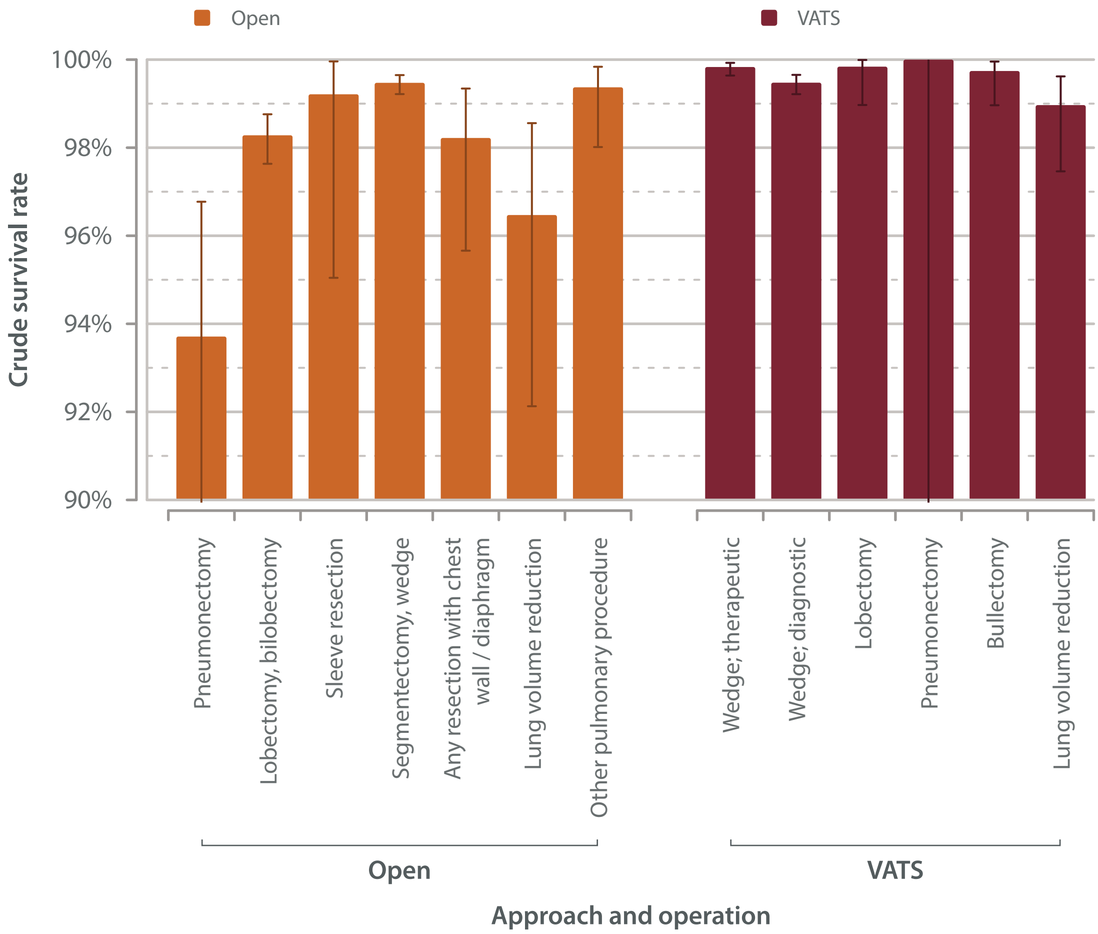
For sublobar VATS resections only, we have data on the indications for surgery, as they were divided into diagnostic and therapeutic procedures in the dataset. In 2013-2014, therapeutic reasons overtook diagnostic reasons as the commonest indication for VATS wedge resections (Fig. 3.02). This might reflect an increase in surgery for lung metastases, but we do not have pathological data available to be certain about this.

i. Any pulmonary resection with resection of chest wall, diaphragm etc.

Pooled mortality data for 2010-2015 is shown in Fig. 3.03, with the source data in Table 3.01. LVRS surgery has relatively low survival compared to other procedures in both the open and VATS groups. This very likely reflects the burden of severe emphysema suffered by these patients. Similarly, diagnostic VATS wedge resections have a slightly lower absolute survival than therapeutic (99.5% *versus* 99.8%). This may reflect a greater incidence of underlying lung disease and therefore poorer lung function in the diagnostic group, leading to lower survival.

Further analysis of this procedure group is challenging without comorbidity data. It is likely that some of the differences in survival observed between operation types and surgical approaches is a result of systematic differences between patient groups, and related to the underlying conditions being diagnosed or treated.

Fig. 3.03 **Resections for lung conditions other than primary lung cancer: Survival to discharge and procedure; 2010-2015**



References

1. NICE Interventional procedures guidance: insertion of endobronchial valves for lung volume reduction in emphysema [IPG465]. https://www.nice.org.uk/guidance/ipg465.
2. Lim E, Baldwin D, Beckles M, Duffy J, Entwisle J, Faivre-Finn C, Kerr K, Macfie A, McGuigan J, Padley S, Popat S, Screaton N, Snee M, Waller D, Warburton C, Win T. Guidelines on the radical management of patients with lung cancer. *Thorax*. 2010; **65**: iii1-iii27.

Chapter 4: Surgery for chest wall deformity and mesothelioma

Surgery for chest wall deformity

Pectus abnormalities are a common developmental problem affecting around one in every 400 people in the United Kingdom [1,2]. They tend to present in childhood and as teenagers and often become most pronounced as the child grows most quickly in the early teenage years. 75% of these patients have pectus excavatum and the remainder have pectus carinatum or a range of asymmetrical defects. A small number have a mixed defect called pectus arcuatum.

The most usual indication for surgery is for cosmetic improvement, although there is a convincing body of papers documenting pre-operative exercise intolerance and shortness of breath [3-6] and then subsequent improvement after surgery [7-11] with the largest improvements being in those with the more severe excavatum deformities.

This section documents an impressive volume of work being performed by United Kingdom thoracic surgeons in this area, with 429 minimally invasive and 1,143 open repairs reported between 2010-2015. In addition, United Kingdom thoracic surgeons should be proud of the fact that there were no in-hospital deaths after repair by either approach during the audit period.

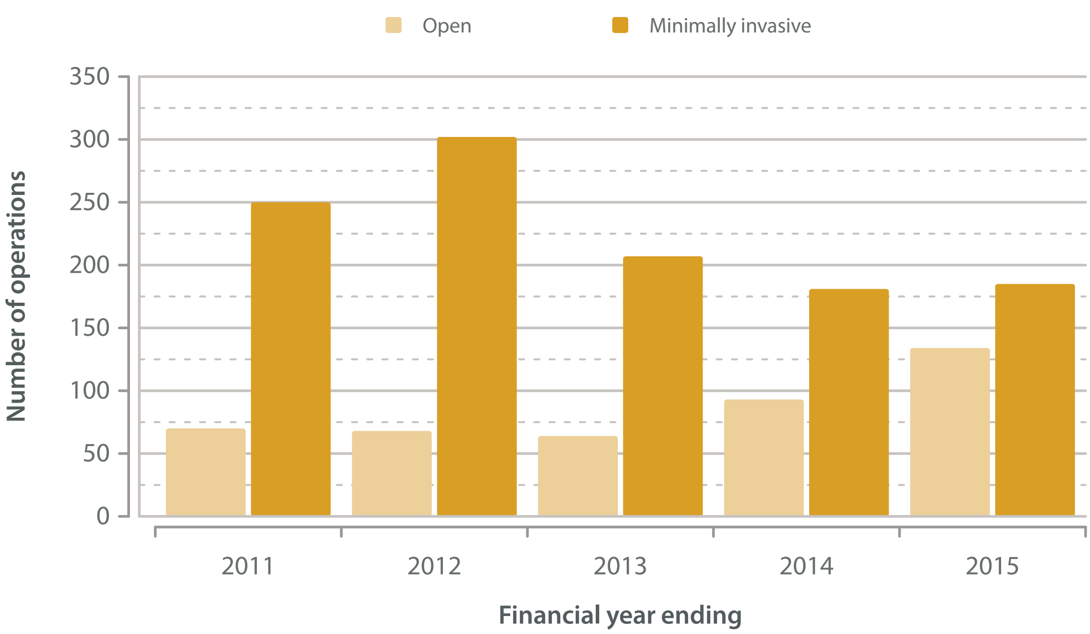
The figures presented in this report show that open repair is still the most common technique to repair the pectus abnormality, but that minimally invasive surgery is increasing in popularity (Fig. 4.01). It is assumed that the vast majority of minimally invasive surgery is the NUSS procedure for pectus excavatum although, a very small number could also potentially be the Yuksel procedure (sometimes called the reverse NUSS procedure) for pectus carinatum [12].

It is good to see that surgery for pectus abnormalities is offered widely across the country and that most units offer this surgery to a varying degree (Fig. 4.02). The incidence of open to minimally invasive surgery varies, but interestingly some of the largest volume providers have a lower proportion of minimally invasive surgery than the smaller units, which is perhaps the reverse of what might be expected.

However, the arguments in favour, or against, minimally invasive pectus surgery are very different to that in VATS lobectomy as the NUSS procedure has some additional risks intra-operatively, may be more painful than the Ravitch procedure and requires bar removal after 3 years, and thus many would actually view the NUSS procedure as a higher risk operation overall compared to Ravitch in order to achieve a smaller total scar burden.

Of note, thoracic surgeons are not the only specialty performing these operations. We are aware of paediatric surgeons in the United Kingdom who also perform these operations but do not contribute to our audit, and this is an operation that is not infrequently performed in private hospitals, thus the number is certain to be higher nationally in terms of operations performed and hospitals offering surgery than we capture in the SCTS registry.

Fig. 4.01 **Correction of pectus deformity: Number of operations and approach (n=1,554)**



In addition to these surgical patients, many young people come seeking advice but do not end up selecting surgery. Some are happy to continue conservative treatment, but some receive bracing or suction bell treatments, which are not captured in this audit but can help patients with this condition.

In February 2016 the continuation of this service in England was thrown into doubt by the NHS England Specialised Services Clinical Reference Group for Thoracic Surgery, who published the document entitled: Clinical Commissioning Policy Proposition: Surgical Correction For Pectus Deformity [13]. This document stated that:

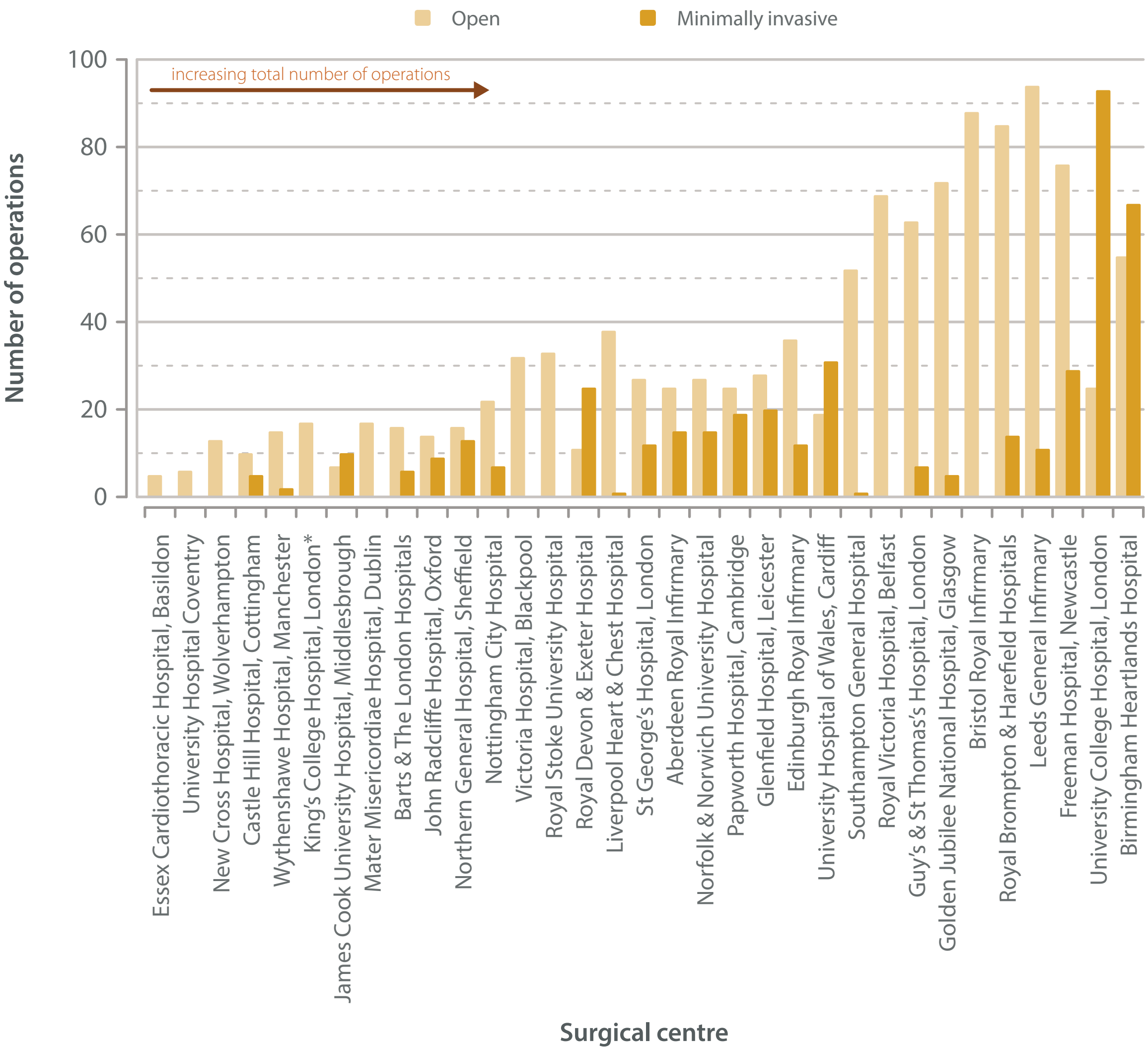
> *NHS England has concluded that there is not sufficient evidence to support a proposal for the routine commissioning of surgical correction of pectus deformity*

thus indicating the intention to stop any pectus surgery being offered on the NHS.

Thus, while there is a large amount of work being performed by Thoracic surgeons in the United Kingdom as documented in this audit, and an additional amount of work that is being performed that is not captured fully in this audit, the service in England is currently under threat in the current era of restricted NHS funding. It is imperative that our specialty comes together to decide how we would like the future of pectus surgery to evolve and whether we advocate for its continued availability on the NHS or allow its transfer to the private sector, with only occasional operations on the NHS after Individual Funding Request applications based on a perceived symptomatic benefit. The timeline for implementation of this NHS England proposal is currently unknown.

429 minimally invasive and 1,143 open repairs were reported between 2010-2015. There were no in-hospital deaths after repair by either approach during the audit period.

Fig. 4.02 **Correction of pectus deformity: Number of operations *per* surgical centre and approach; financial years 2011-2015 (n=1,554)**



Mesothelioma surgery

In comparison to resection of lung cancer, surgery for mesothelioma makes up only a minor part of the workload of thoracic surgeons, with 1,221 operations performed over the past five years. Between 2002 and 2009, the section on mesothelioma surgery was omitted from the SCTS Thoracic Register. During this time, any such operations would have been classified under the more generic sections on pleural procedures, other lung resection with resection of chest wall / diaphragm, or chest wall / diaphragmatic procedures.

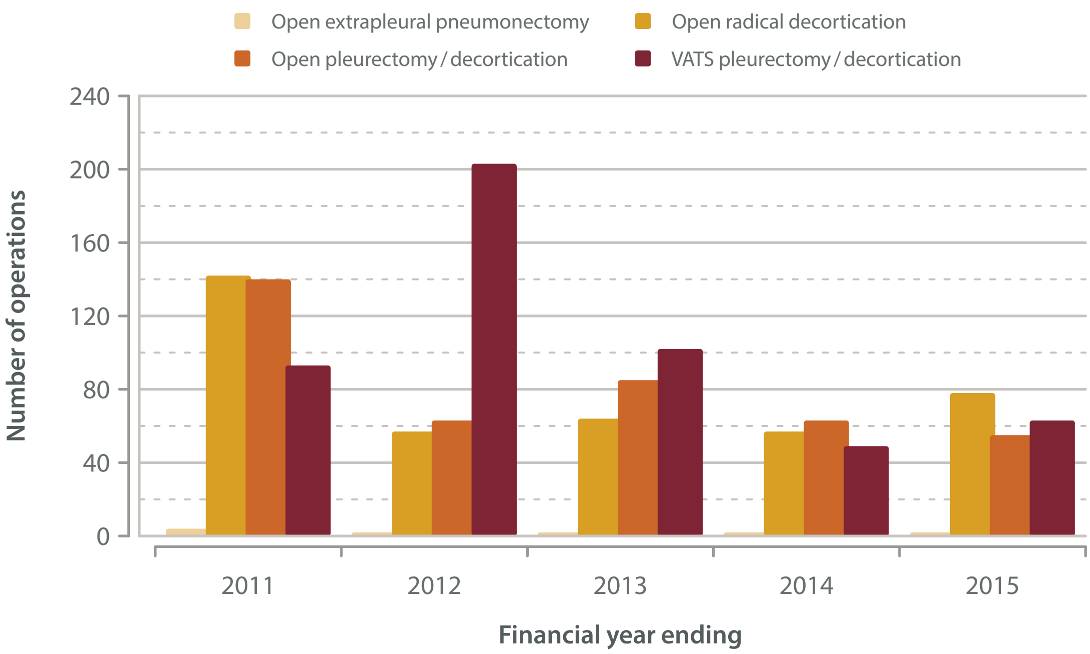
From 2009, with two on-going United Kingdom mesothelioma surgical trials (the MARS and MesoVATS trials), the section on mesothelioma surgery made a comeback to the Thoracic Register, reflecting the change in practice that was taking place in the United Kingdom. These procedures have been classified in the Thoracic Register along the same lines as the IASLC (the International Association for the Study of Lung Cancer) and IMIG (International Mesothelioma Interest Group) group nomenclature.

Extrapleural pneumonectomy (EPP) is a radical operation performed for malignant pleural mesothelioma, where all the visceral and parietal pleura, the diaphragm and pericardium are removed en bloc, with reconstruction of the pericardial and diaphragmatic defects. Only a handful of cases a year have been done since the publication of results from the MARS trial in 2011 [14], in contrast to the 26 and 35 EPP operations reported to the Thoracic Register in 2000-2001 and 2001-2002 respectively.

The MARS trial was a randomised feasibility study comparing EPP to no EPP within a tri-modal setting. Though not statistically significant, the median quality of life scores were lower in the EPP group, and a full MARS trial was not felt to be feasible in light of the high morbidity associated with EPP and the suggestion that EPP offers no benefit and possibly harms patients.

With EPP playing a diminishing role in the surgical management of pleural mesothelioma, there has been a drift towards less extensive surgery, in particular lung preservation surgery (Fig. 4.03). Open radical decortication, also known as extended pleurectomy decortication, involves removing all gross tumour with resection of the diaphragm and / or pericardium, leaving the underlying lung intact. Open pleurectomy decortication (P / D) involves removal of all gross tumour from the visceral and parietal pleura without diaphragmatic or pericardial resection. Both these procedures appear to have replaced EPP in 2010-2011, likely in response to the MARS trial, as well as results from other non-randomised studies including a large observational study pooling outcome data for 663 patients undergoing EPP or P / D [15]. In the latter study, P / D was associated with lower operative mortality and longer median survival when compared to EPP. However, without data from randomised studies, subsequent years saw the number of radical decortication and P / D fall and remain fairly static. The MARS 2 trial, a United Kingdom-wide, multi-centre randomised trial, aims to assess the benefits of extended pleurectomy

Fig. 4.03 **Surgery for pleural meothelioma: Number of operations (n=1,326)**

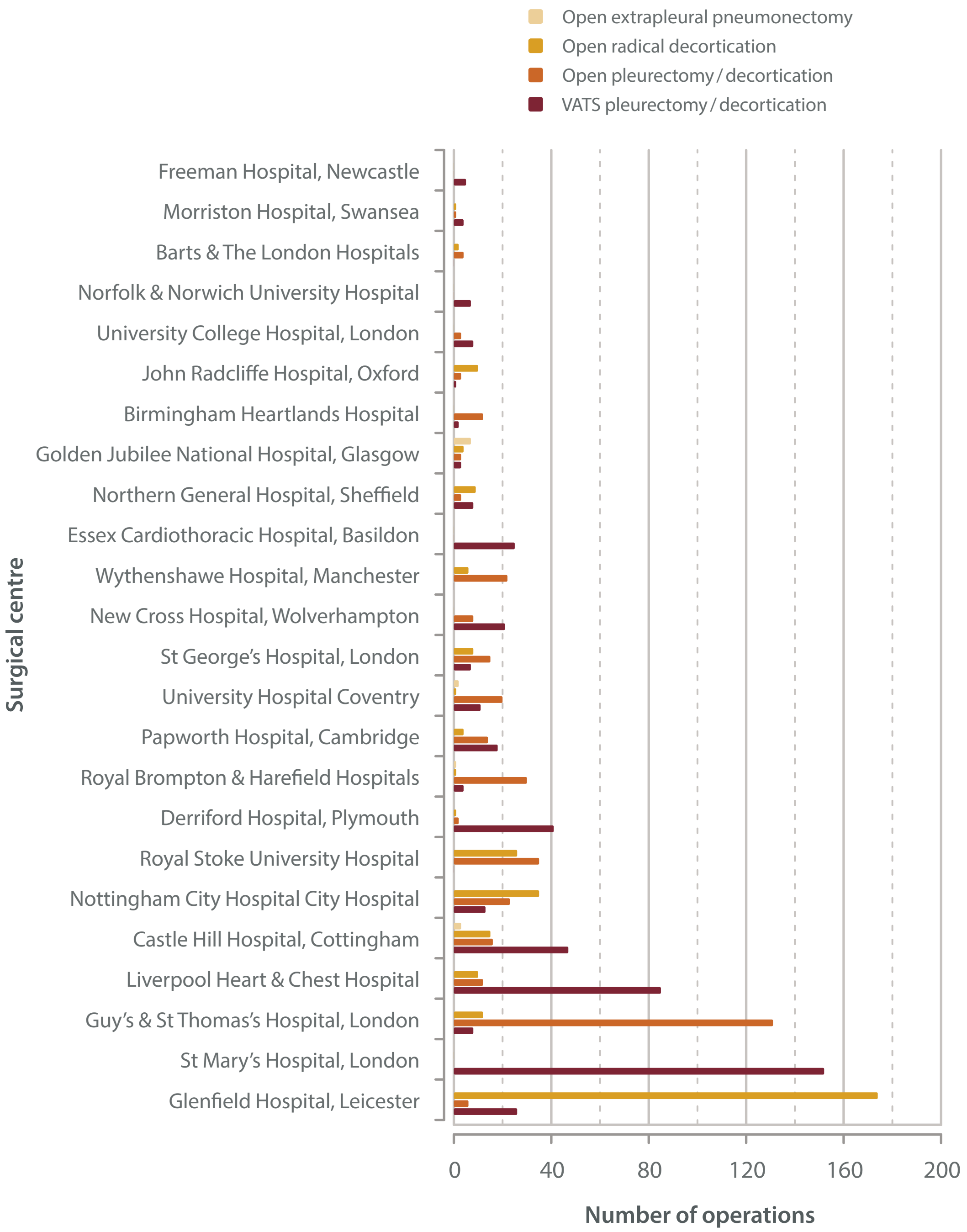


decortication *versus* no pleurectomy decortication within a multi-modality setting (trial number NCT02040272 at clinicaltrials.gov). It has been recruiting patients since 2015. With outcome measures including survival and quality of life, there will no doubt be a further shift in practice in the years to come.

VATS pleurectomy decortication is for all intents and purposes a debulking procedure where there is partial removal of tumour from the parietal and / or visceral pleura. The objectives are to free up an underlying trapped lung, reduce pain from tumour abutting the chest wall and intercostal nerves, and achieve pleurodesis, thereby palliating symptoms of breathlessness and pain. The MesoVATS trial was a randomised study in the United Kingdom of VATS partial pleurectomy *versus* talc pleurodesis in patients with a pleural effusion secondary to mesothelioma [16]. It recruited patients between 2003 and 2012, and showed no difference in overall survival at

Fig. 4.04

Surgery for pleural meothelioma: Number of operations; financial years 2011-2015 (n=1,191)



1 year between the two groups. VATS partial pleurectomy improved the control of recurrent effusion in the first 6 months after surgery and improved quality of life for 12 months, but had a higher surgical complication rate and longer median length-of-stay. There was a marked reduction in the number of VATS pleurectomy decortication procedures in the United Kingdom from 2012 onwards, following the conclusion of the MesoVATS trial, and likely as a response to the trial results (Fig. 4.03).

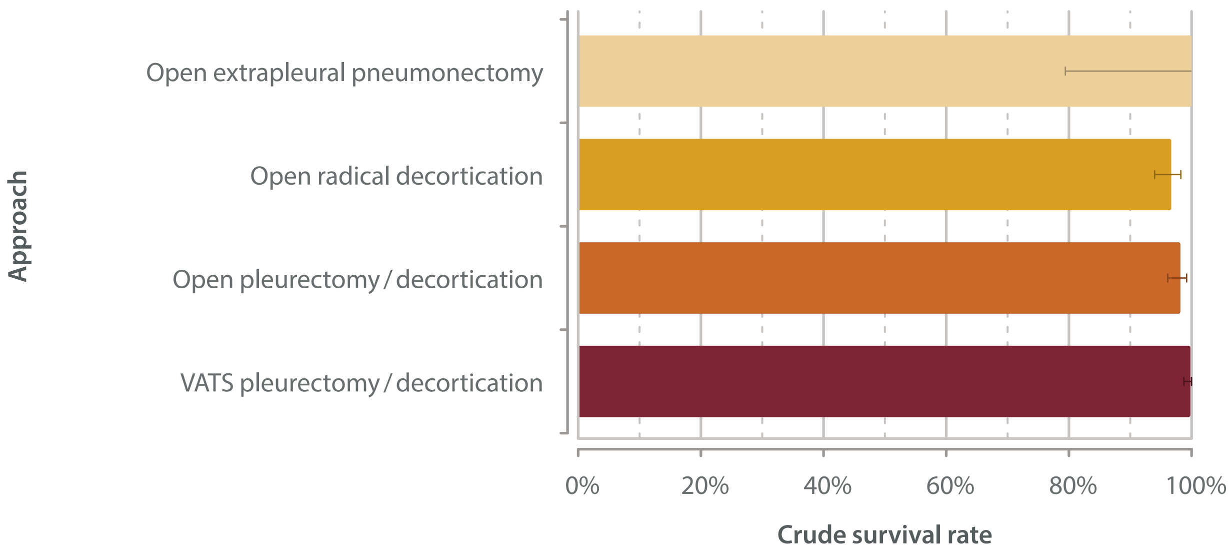
Surgery for mesothelioma is largely performed in specialised units, with only four units performing more than 100 operations over the five-year period, and only one unit performing more than 200 operations (Fig. 4.04). In the 13 patients who underwent EPP in the past five years, there has been no in-hospital mortality. Mortality for the remaining three operations appears to be related to the extent of surgery; highest with open radical decortication (3.4%) and lowest with VATS pleurectomy decortication (0.2%) (Fig. 4.05, Table 4.01).

Table 4.01 **Surgery for pleural mesothelioma:** in-hospital survival and approach; financial years 2011-2015

		In-hospital outcome		
		Survivors	Deaths	Survival rate
Approach	Open extrapleural pneumonectomy	13	0	100.0%
	Open radical decortication	321	11	96.7%
	Open pleurectomy / decortication	377	7	98.2%
	VATS pleurectomy / decortication	510	1	99.8%

Fig. 4.05

Surgery for pleural meothelioma: In-hospital survival; financial years 2011-2015 (n=1,240)



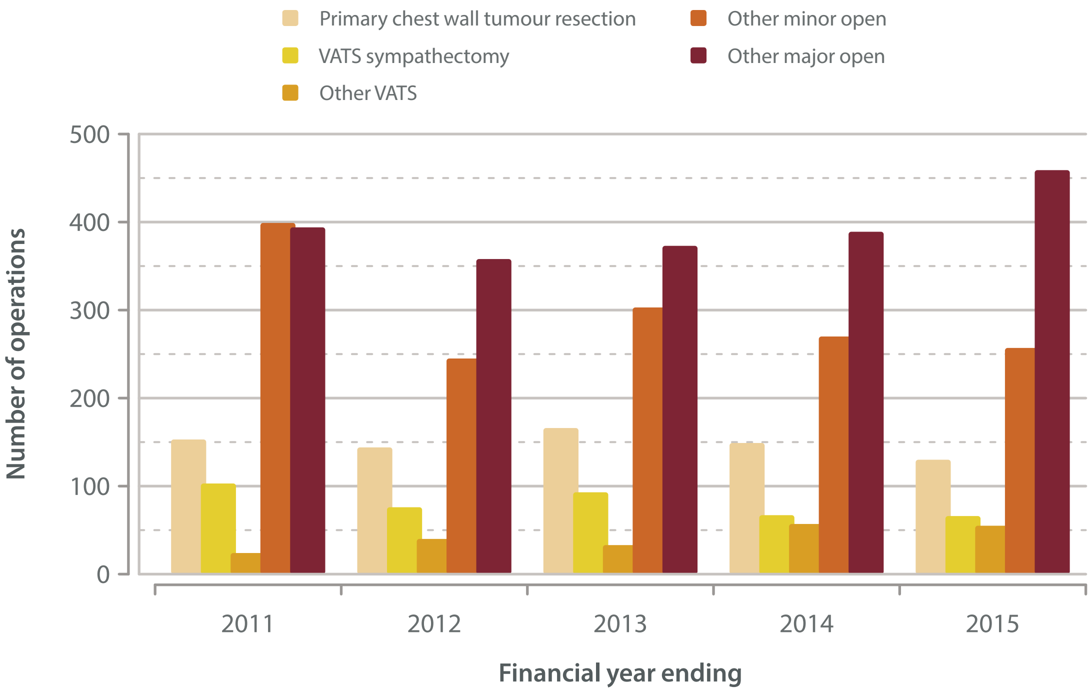
Primary chest wall tumours and chest wall surgery NOS

Outside surgery for deformity and pleural mesothelioma, chest wall surgery is performed for primary chest wall tumours, infections, trauma and other conditions.

Primary chest wall tumour excision surgery, which includes surgery for soft tissue and bony sarcomas amongst other pathologies, has remained stable at around 150 cases *per* year (Fig. 4.06). Primary lung cancer that has extended to involve the chest wall is not included in these charts.

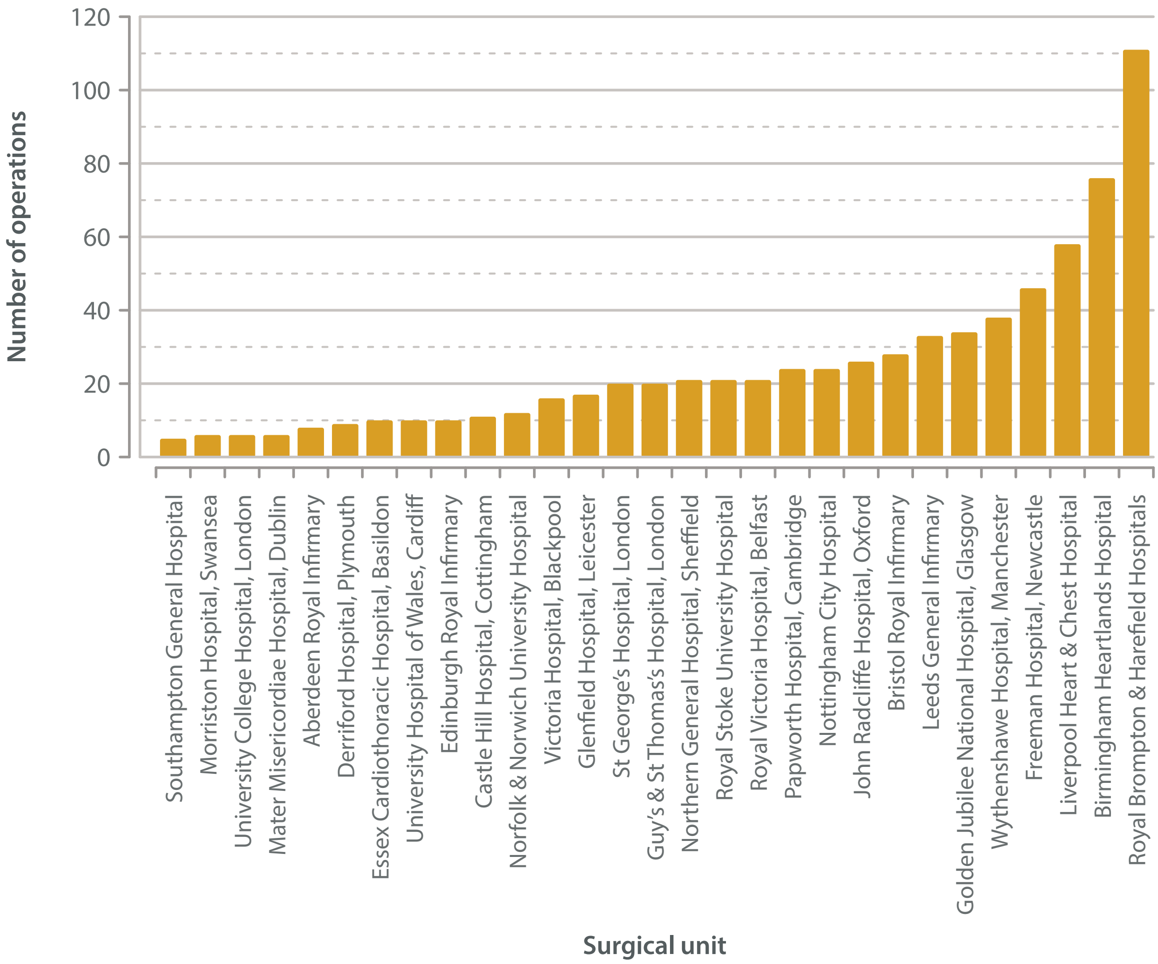
In 2010 the National Institute for Health and Care Excellence (NICE) approved rib fixation for patients with multiple traumatic rib fractures (NICE IPG 361) [17]. The increase in *other major open* seen (Fig. 4.06) might reflect an increase in activity, but during this period we did not specifically collect data on rib fixation. This has been updated in our latest proforma, and we will be able to report this activity specifically in subsequent years.

Fig. 4.06 **Non-pectus chest wall surgery: Number of operations (n=4,803)**



Chest wall surgery is concentrated, like several other small volume procedures, in a handful of larger units (Fig. 4.07). It is likely that thoracic units serving major trauma centres and sarcoma MDTs see more referrals for chest wall surgery than units that do not.

Fig. 4.07 **Primary chest wall tumour resections; financial years 2011-2015 (n=727)**



Survival after chest wall surgery (Table 4.02) is reassuringly high. Only the *open major: other* group has recorded a pooled in-hospital survival rate below 99%, another reason for subclassifying this group to better understand the procedures being coded.

One interesting category captured is VATS sympathectomy. The incidence of this operation seems to be dropping. There are many reasons that might account for this, including other specialties such as vascular surgery performing these operations, and increasing alternatives to surgery such as medical therapy and botox injections.

Table 4.02 **Non-pectus chest wall surgery:** in-hospital survival and procedure; financial years 2011-2015

		In-hospital outcome		
		Survivors	Deaths	Survival rate
Operation	Primary chest wall tumour resection	739	3	99.6%
	Other open major	1,942	31	98.4%
	Other minor	1,462	12	99.2%
	VATS sympathectomy	404	1	99.8%
	Other VATS	209	0	100.0%

Reference list

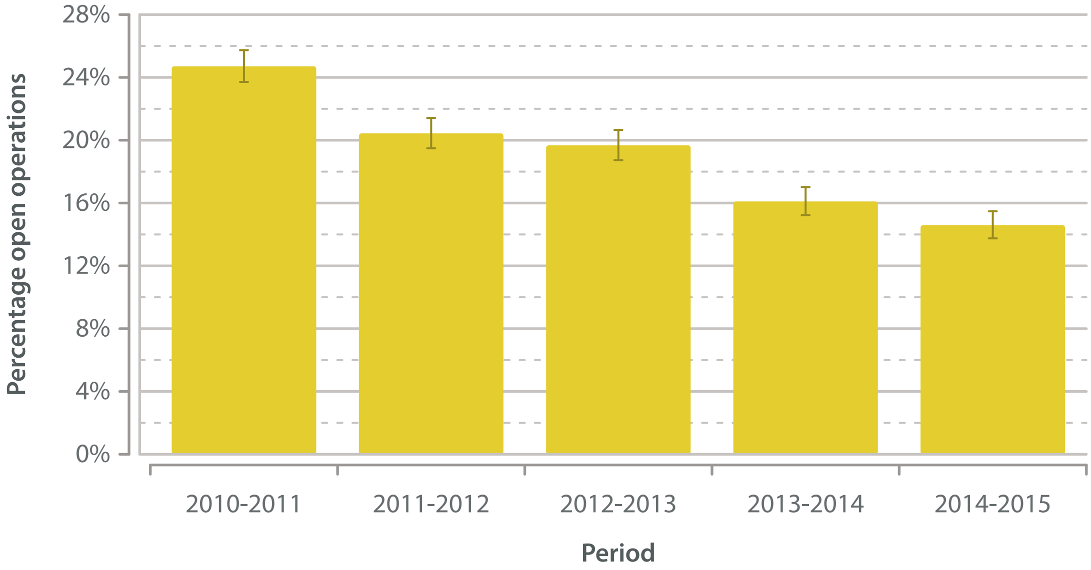
1. Fonkalsrub EW. Current management of pectus excavatum. *World Journal of Surgery*. 2003; **27(5)**: 502-508.
2. Kelly RE, Lawson ML, Paidas CN, et al. Pectus excavatum in a 112-year autopsy series: anatomic findings and the effect on survival. *Journal of Pediatric Surgery*. 2005; **40**: 1275-1278.
3. Kelly RE, Jr. Pectus excavatum: historical background, clinical picture, pre-operative evaluation and criteria for operation. *Seminars in Pediatric Surgery*. 2008; **17**: 181-193.
4. Kelly RE, Jr., Cash TF, Shamberger RC, Mitchell KK, Mellins RB, Lawson ML, Oldham K, Azizkhan RG, Hebra AV, Nuss D, Goretsky MJ, Sharp RJ, Holcomb GW, 3rd, Shim WK, Megison SM, Moss RL, Fecteau AH, Colombani PM, Bagley T, Quinn A, Moskowitz AB. Surgical repair of pectus excavatum markedly improves body image and perceived ability for physical activity: multicenter study. *Pediatrics*. 2008; **122**: 1218-1222.
5. Rowland T, Moriarty K, Banever G. Effect of pectus excavatum deformity on cardiorespiratory fitness in adolescent boys. *Archives of Pediatrics & Adolescent Medicine*. 2005; **159**: 1069-1073.
6. Maagaard M, Tang M, Ringgaard S, Nielsen HH, Frokiaer J, Haubuf M, Pilegaard HK, Hjortdal VE. Normalized cardiopulmonary exercise function in patients with pectus excavatum three years after operation. *Annals of Thoracic Surgery*. 2013; **96**: 272-278.
7. Neviere R, Montaigne D, Benhamed L, Catto M, Edme JL, Matran R, Wurtz A. Cardiopulmonary response following surgical repair of pectus excavatum in adult patients. *European Journal of Cardiothoracic Surgery*. 2011; **40**: e77-82.
8. Redlinger RE, Jr., Kelly RE, Nuss D, Goretsky M, Kuhn MA, Sullivan K, Wootton AE, Ebel A, Obermeyer RJ. Regional chest wall motion dysfunction in patients with pectus excavatum demonstrated via optoelectronic plethysmography. *Journal of Pediatric Surgery*. 2011; **46**: 1172-1176.
9. Redlinger RE, Jr., Wootton A, Kelly RE, Nuss D, Goretsky M, Kuhn MA, Obermeyer RJ. Optoelectronic plethysmography demonstrates abrogation of regional chest wall motion dysfunction in patients with pectus excavatum after Nuss repair. *Journal of Pediatric Surgery*. 2012; **47**: 160-164.
10. Jacobsen EB, Thastum M, Jeppesen JP, Pilegaard HK. Health related quality of life in children and adolescents undergoing surgery for pectus excavatum. *European Journal of Pediatric Surgery*. 2010; **20(2)**: 85-91.
11. Krasopoulos G, Dusmet M, Ladas G, Goldstraw P. Nuss procedure improves the quality of life in young male adults with pectus excavatum deformity. *European Journal of Cardiothoracic Surgery*. 2006; **29**: 1-5.
12. Yüksel M, Bostanci K, Evman S. Minimally invasive repair of pectus carinatum using a newly designed bar and stabilizer: a single-institution experience. *European Journal of Cardiothoracic Surgery*. 2011; **40(2)**: 339-342.
13. Clinical Commissioning Policy Proposition: Surgical Correction For Pectus Deformity (all Ages): February 2016: NHS England B10X01/01.
14. Treasure T, Lang-Lazdunski L, Waller D, Bliss JM, Tan C, Entwisle J, Snee M, O'Brien M, Thomas G, Senan S, O'Byrne K, Kilburn LS, Spicer J, Landau D, Edwards J, Coombes G, Darlison L, Peto J for the MARS trialists Extra-pleural pneumonectomy versus no extra-pleural pneumonectomy for patients with malignant pleural mesothelioma: clinical outcomes of the Mesothelioma and Radical Surgery (MARS) randomized feasibility study. *Lancet Oncology*. 2011; **12(8)**: 763-72.
15. Flores RM, Pass HI, Seshan VE, Dycoco J, Zakowski M, Carbone M, Bains MS, Rusch VW Extrapleural pneumonectomy versus pleurectomy/decortication in the surgical management of malignant pleural mesothelioma: results in 663 patients. *Journal of Thoracic & Cardiovascular Surgery*. 2008; **135(3)**: 620-6.
16. Rintoul RC, Ritchie AJ, Edwards JG, Waller DA, Coonar AS, Bennet M, Lovato E, Hughes V, Fox-Rushby JA, Sharples LD for the MesoVATS Collaborators Efficacy and cost of video-assisted thoracoscopic partial pleurectomy versus talc pleurodesis in patients with malignant pleural mesothelioma (MesoVATS): an open-label, randomized, controlled trial. *Lancet*. 2014; **384(9948)**: 1118-27.
17. NICE Interventional Procedures Guidance 361: October 2010, Insertion of metal rib reinforcements to stabilise a flail chest wall https://www.nice.org.uk/guidance/ipg361.

Chapter 5: Benign pleural surgery

This group of procedures includes surgery for pleural sepsis, surgery for pneumothorax or management of air leak, and pleural biopsy procedures performed by surgeons. Radical surgery for mesothelioma is covered separately in chapter four.

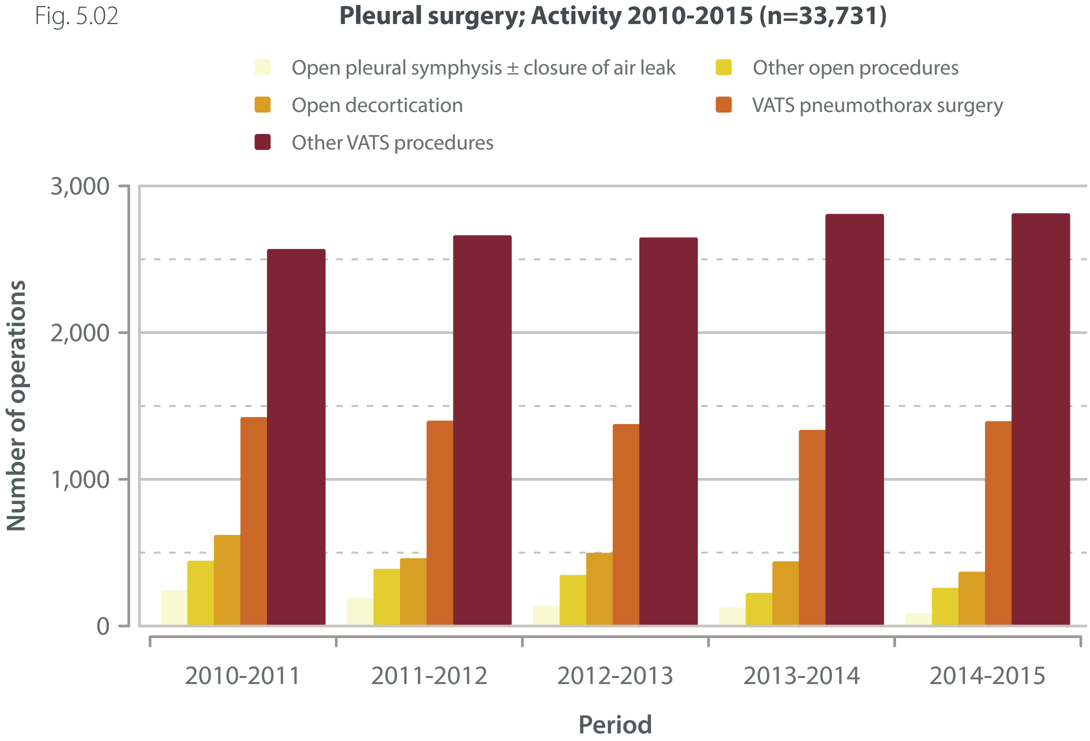
Pleural operations were predominantly performed *via* a VATS approach, with the proportion continuing to rise slowly from 2010-2015 (Fig. 5.01).

Fig. 5.01 **Pleural surgery: Surgical approach; 2010-2015; (n=33,731)**



Pleural surgery is a large part of the work of thoracic surgeons. Across the entire SCTS thoracic register, the most commonly reported procedures between 2010-2015 were thoracoscopic *other pleural procedures*, a classification including pleural biopsies and the thoracoscopic management of pleural sepsis. Thoracoscopic pneumothorax surgery was the most common disease-specific procedure reported. Changes in absolute activity over time are shown in (Fig. 5.02).

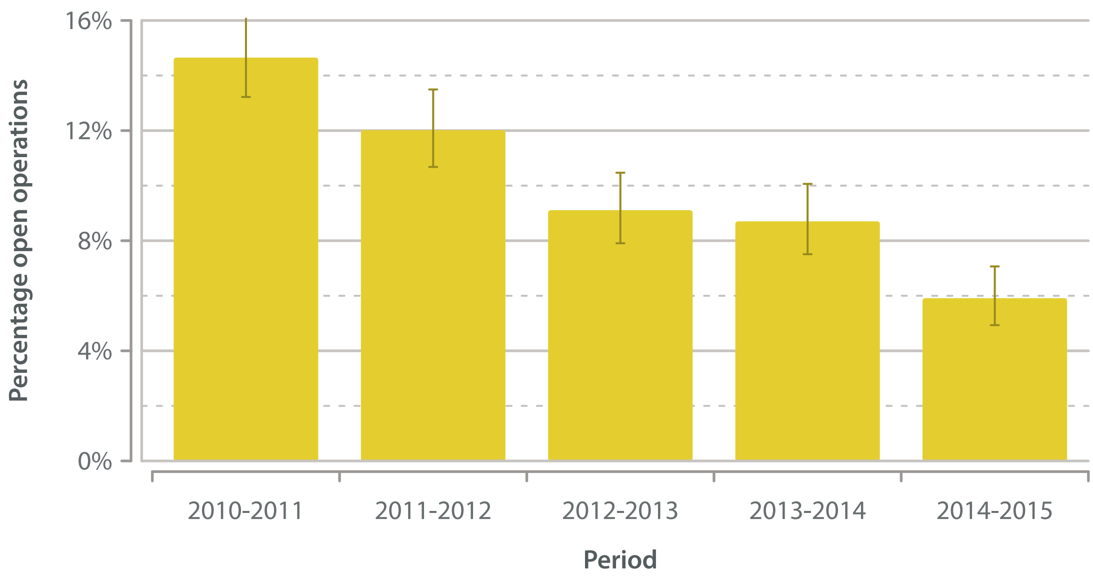
Fig. 5.02



Pneumothorax surgery

10,299 pneumothorax procedures were reported between 2010-2015. 9,247 (89.8%) of these procedures were performed thoracoscopically. The number of VATS pneumothorax procedures remained relatively static, but the small volume of open surgeries performed fell by 64% (326 in 2010-2011, 117 in 2014-2015). This led to a slight fall in the proportion of surgery that was performed through an open approach (Fig. 5.03).

Fig. 5.03 **Pneumothorax surgery: Surgical approach; 2010-2015; (n=10,299)**

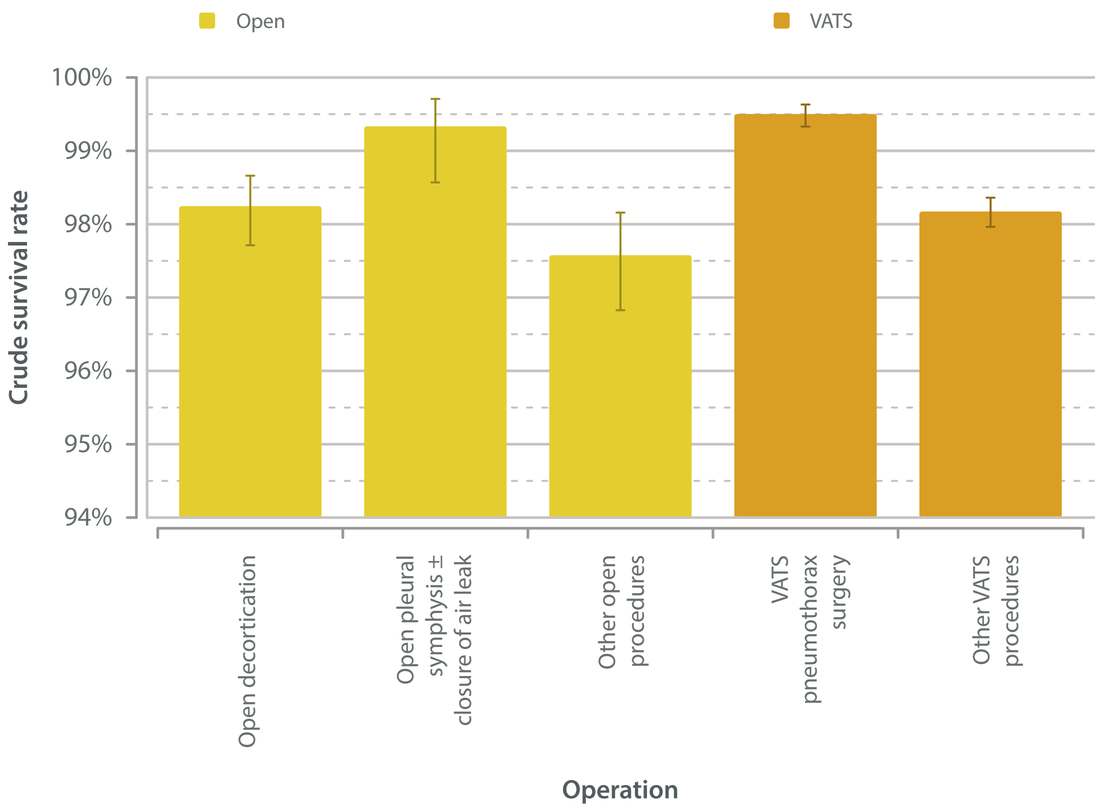


Survival was high, with 99.3% of open and 99.5% of VATS pneumothorax patients surviving to discharge (Table 5.01; Fig. 5.04). Pneumothorax patients are understood to be a diverse group. Young, fit patients will be included, along with older, less fit patients suffering from secondary pneumothorax as a complication of underlying lung disease. The overall survival rates reported here are likely not to be representative of some subgroups due to this diversity.

Table 5.01 **Pleural surgery:** in-hospital outcome, approach and operation; 2010-2015

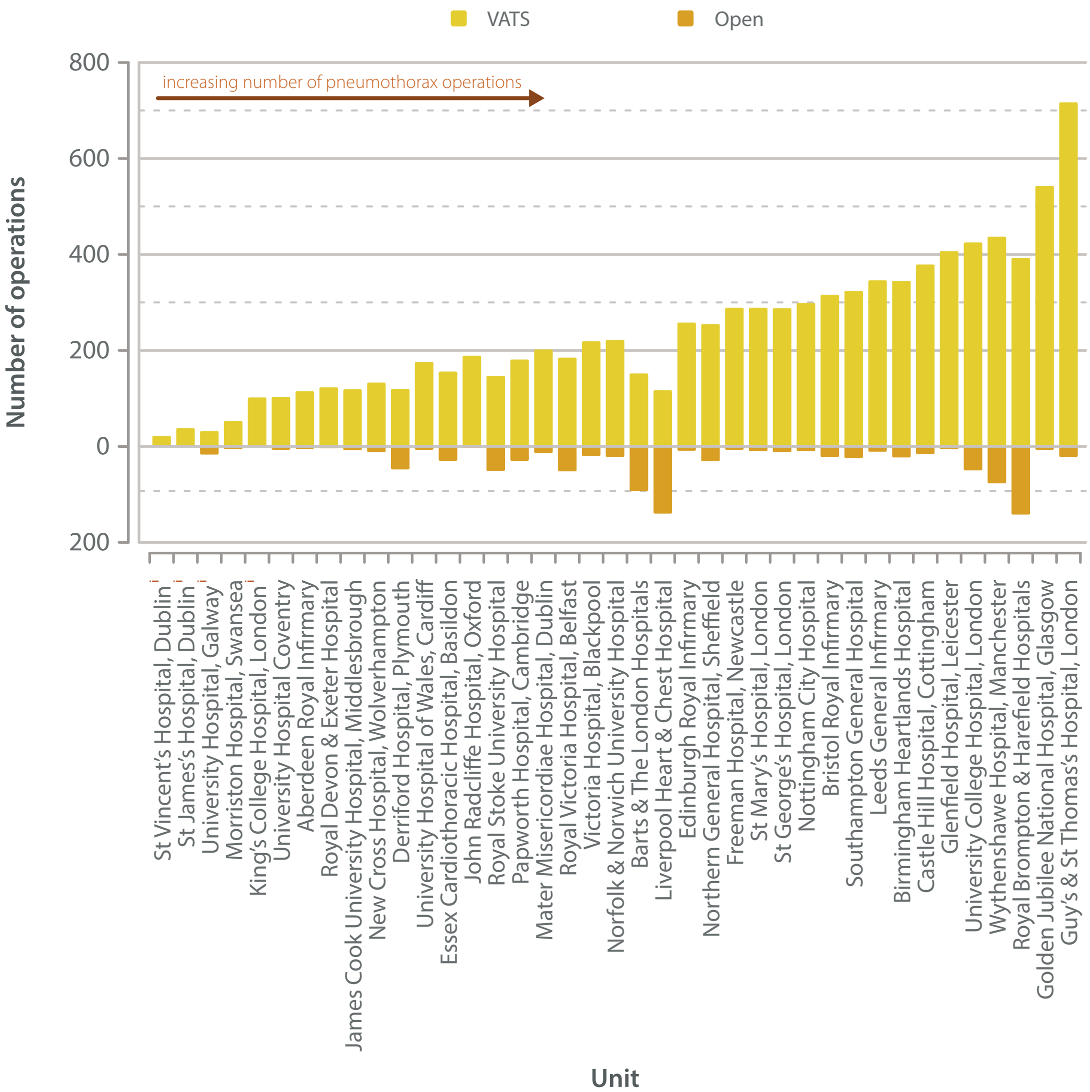
Approach and operation			In-hospital outcome			
			Survival	Death	All	Survival rate
Open	Decortication		3,138	56	**3,194**	98.2%
Open	Pleural symphysis ± closure of air leak		1,045	7	**1,052**	99.3%
Open	Other procedures		2,175	54	**2,229**	97.6%
VATS	Pneumothorax surgery		9,201	46	**9,247**	99.5%
VATS	Other procedures		17,680	329	**18,009**	98.2%

Fig. 5.04 **Pleural surgery: Survival to discharge; 2010-2015 (n=33,731)**



Individual units vary in their use of surgical approaches, with rates of open surgery ranging from 1.3% to 54.5%[i] (Fig. 5.05). There may be local variation in the use of surgery for pneumothorax, with some large units (when measured by total thoracic surgical activity) reporting relatively low levels of activity. Differences in local referral pathways may also play a role.

Fig. 5.05 **Pneumothorax surgery: Activity *per* unit; 2010-2015; (n=10,268)**



i. for the calculation of open pneumothorax surgery unit rates, units performing less than 100 cases in five years were excluded.

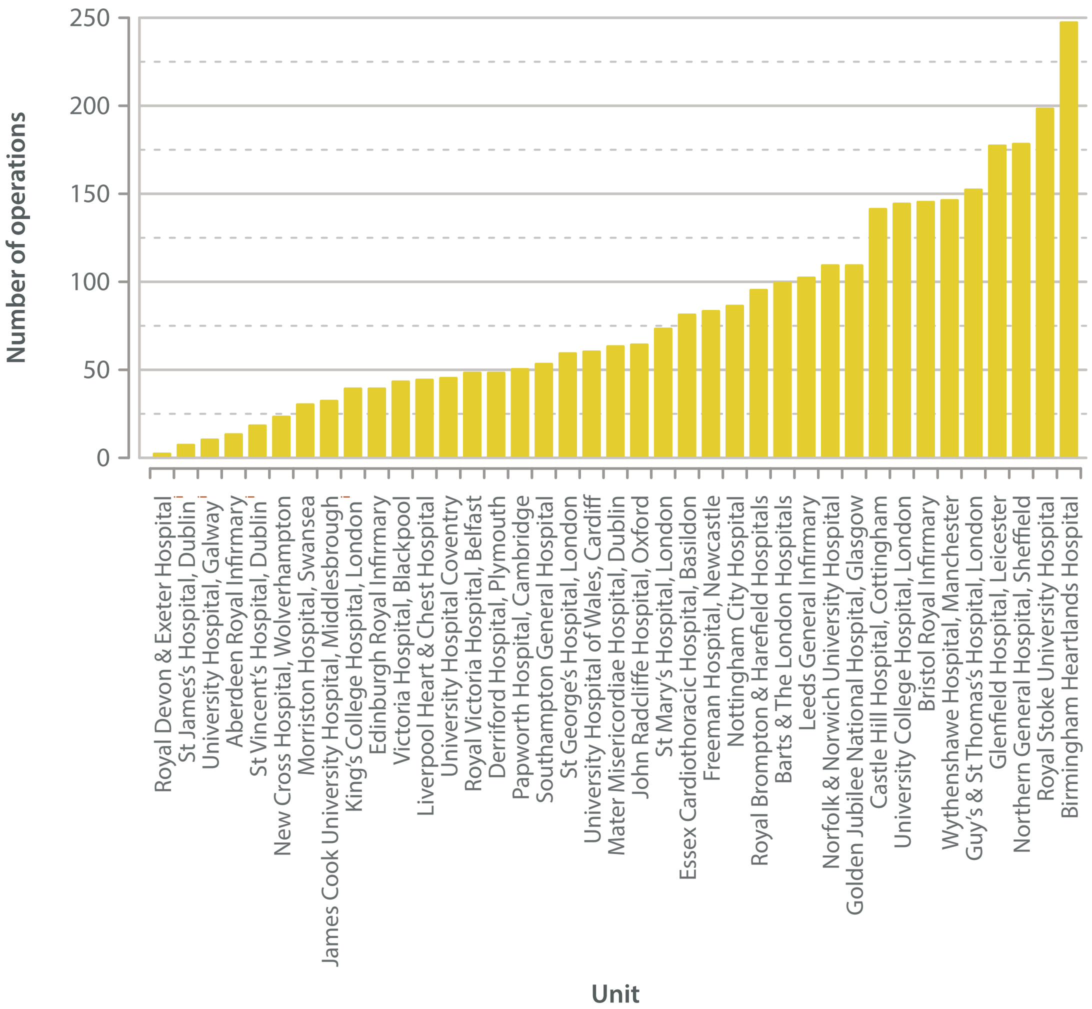
Pleural sepsis surgery

Open pleural sepsis surgery declined from 828 to 494 cases / year between 2010-2011 and 2014-2015, a 40% reduction. Pooled survival to discharge was 98.2% (Table 5.01; Fig. 5.04).

Anecdotally, we believe that more pleural sepsis surgery is now done thoracoscopically, but we cannot confirm this using the registry. Between 2010 and 2015 we did not use a specific code for VATS pleural sepsis surgery. Instead, these cases were coded together with biopsy and other operations as *other pleural procedures*. This has now been changed in our returns template to standardise procedure definitions across open, VATS and robotic surgery.

There is some evidence for variation in practice in pleural sepsis surgery. When ordered by unit size (defined by total thoracic surgical activity), some large units perform less open pleural sepsis surgery than considerably smaller units. For example, Birmingham Heartlands, the seventh largest unit by overall activity in 2010-2015, performed 248 cases while Leeds, the third largest, performed only 103 (Fig. 5.06).

Fig. 5.06 **Open surgery for pleural sepsis: Activity; 2010-2015 (n=3,194)**



There are some possible explanations for these findings. Because we did not record VATS pleural sepsis surgery in a comparable way to open decotication, it is possible that some apparently low activity units were performing their pleural sepsis surgery thoracoscopically. Alternatively, some units may be treating more patients non-surgically, or local referral patterns may direct these cases preferentially towards some units but not to others. More data is required to understand this apparent variation in practice.

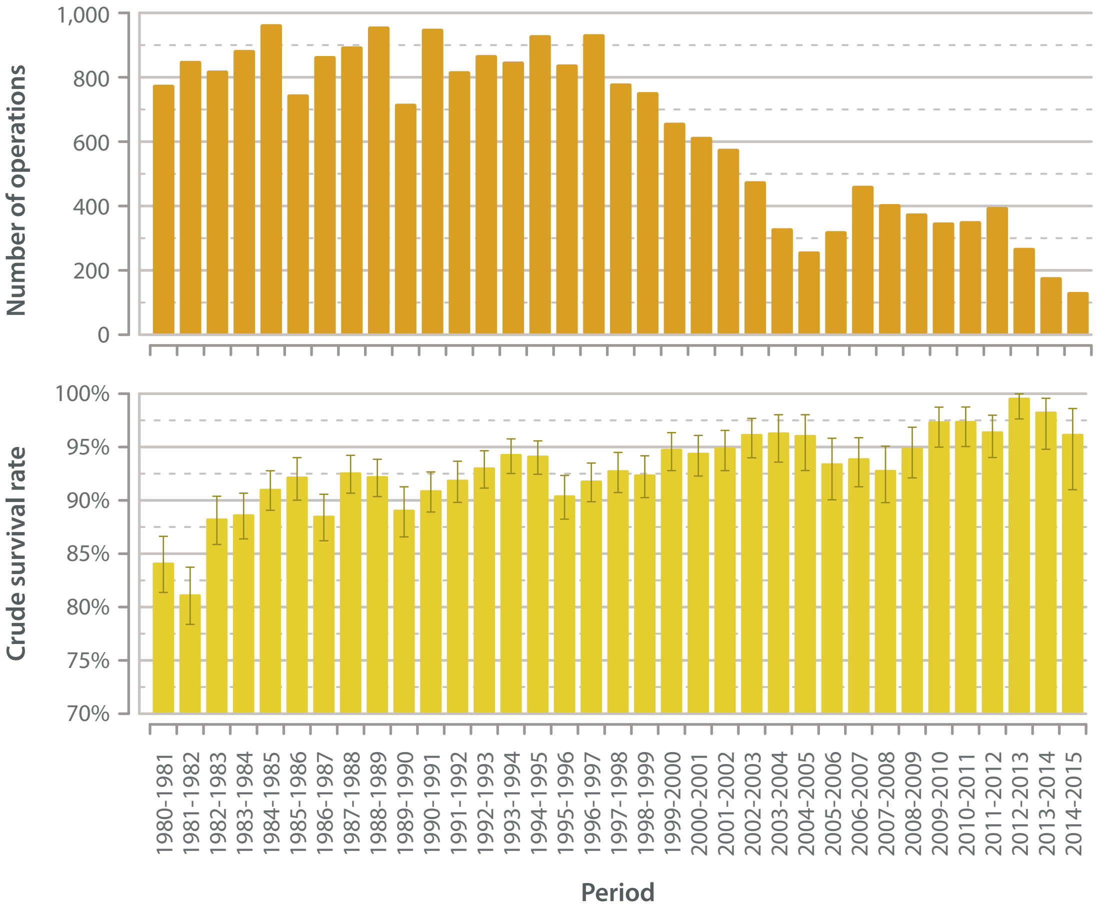
i. Centres did not submit data for every year in the defined analysis period.

Chapter 6: Oesophageal and mediastinal surgery

Oesophagogastric surgery

There has been a striking change in oesophageal cancer practice in the United Kingdom over the last 20 years. Up until 1997, thoracic surgeons consistently performed 800-900 resections *per* year, but in 2014-2015 only 133 resections were performed (Fig. 6.01), despite the rise in oesophageal cancer cases seen and treated in the United Kingdom during that period [1]. Importantly, outside thoracic surgery the amount of surgery performed has actually increased in England and Wales in recent years, as evidenced by the National oesophago-gastric cancer audit [1]. This reflects the development of upper gastrointestinal (GI) surgery as a subspecialty within general surgery, and a transfer of the majority of oesophageal work from thoracic surgery to this new subspecialty.

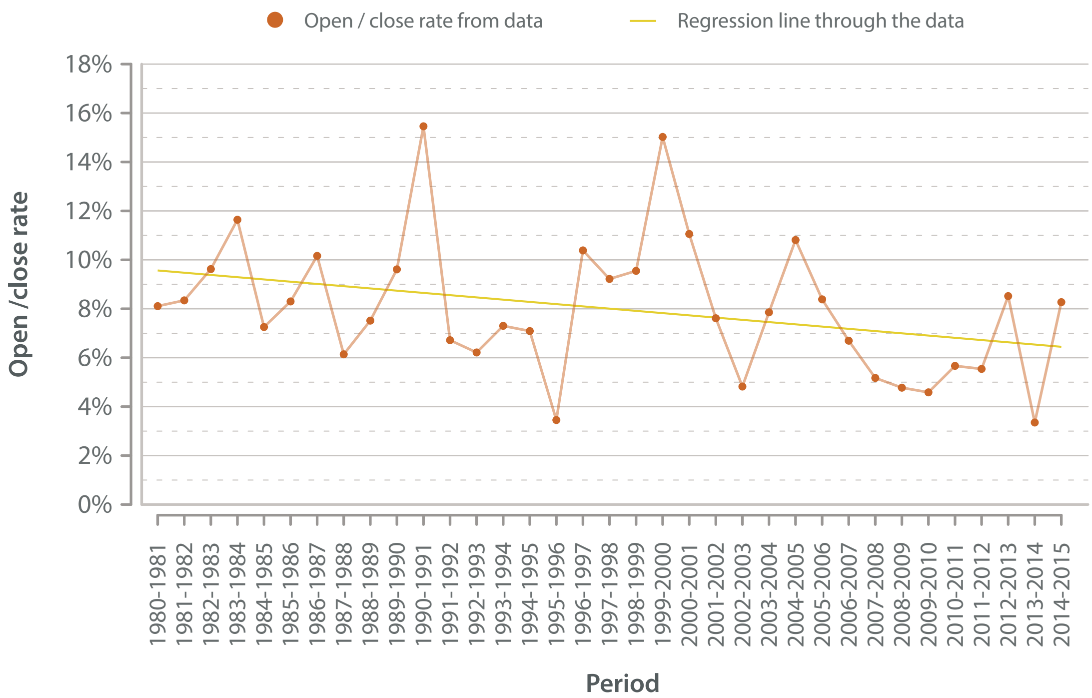
Fig. 6.01 Oesophagogastric resections for malignancy: Activity & survival to discharge; 1980-2015 (n=22,380)



The decline in oesophageal surgery amongst thoracic surgeons has been rapid since a peak in the late 1980s. It may have started following the 1995 Calman-Hine report, A Policy Framework for Commissioning Cancer Services [2], which kick-started the centralisation of specialist curative cancer services. However, it is likely that the initial decrease was due to the introduction of PET staging, beginning in individual hospitals around 2000 and subsequently recommended by national guidance [3]. PET has been shown to improve the detection of distant metastases during staging [4], and may have reduced the number of cases coming forward for inappropriate surgery as a result. Improved staging may also have contributed to the reduction in *open and close* operations seen (Fig. 6.02).

Fig. 6.02

Attempted oesophageal resections for cancer: Open / close rate; 1980-2015



The first annual report of the National Oesophago-Gastric Cancer Audit in 2008 was associated with the subsequent closure of oesophageal services at several thoracic units, which had been performing small numbers of resections.

Between 2010-2015, only seven thoracic units reported 50 or more oesophageal resections, a rate of ten *per* year (Fig. 6.03). With most thoracic units now not performing oesophageal surgery, the capacity to train surgeons in oesophageal surgery within cardiothoracic training programs is very limited. Oesophageal surgery performed by thoracic surgeons seems likely to reduce further in subsequent years.

Despite the reduced activity, the in-hospital survival rate for cancer resections performed by thoracic surgeons has continued to rise, from between 88-95% between 1982-2001 to above 95% since 2009 (Fig. 6.01).

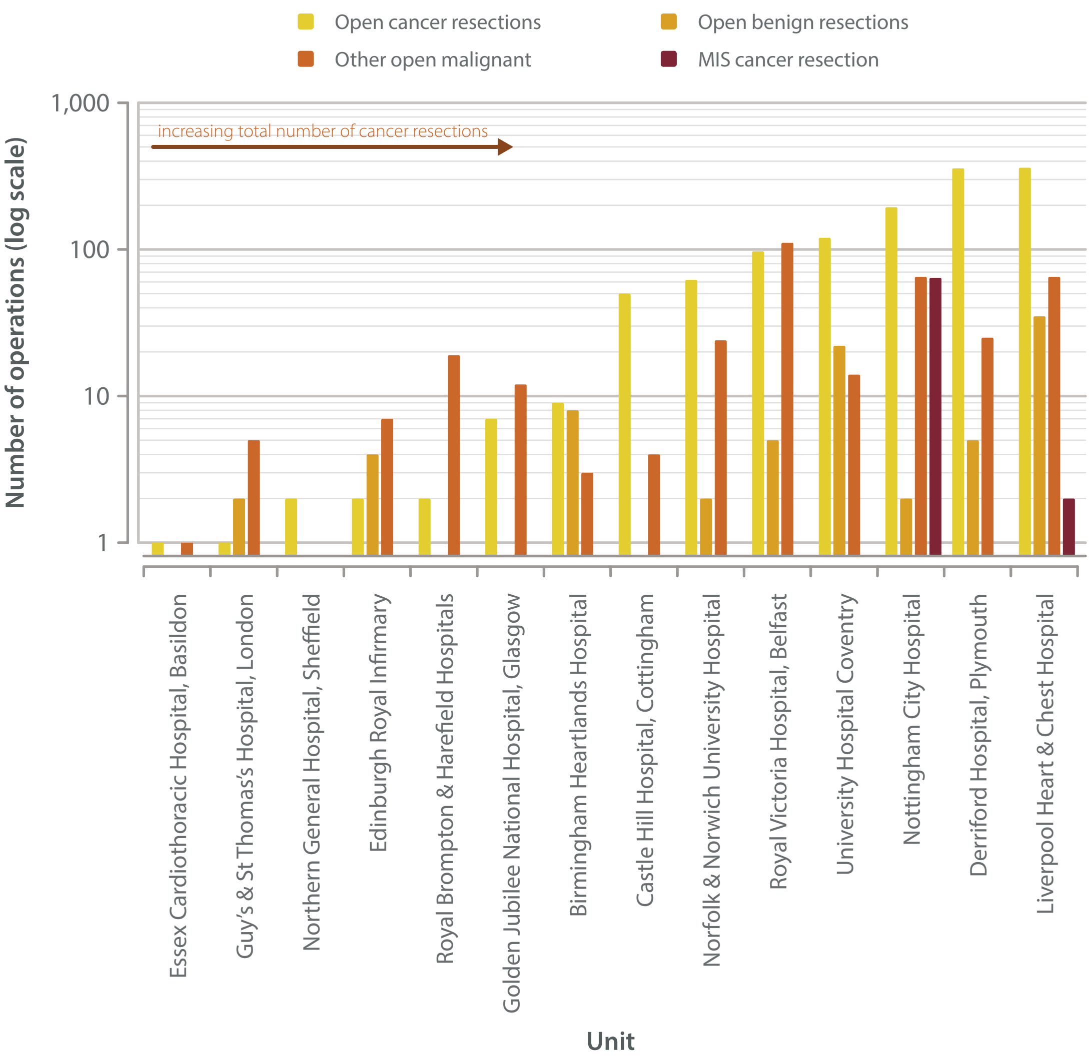
After a short dalliance with minimally invasive oesophagectomy in 2011-2012, this approach was abandoned by thoracic surgeons (Fig. 6.04). This may have contributed to the transfer of resections to upper gastro-intestinal (GI) surgeons, who in 2015 performed 38.9% of oesophagectomies using minimally invasive techniques [1].

Since 1980 there has been a gradual decline in the risk of unsuccessful exploratory procedures (Fig. 6.02). This trend is also apparent in the National Oesophagogastric Cancer Audit, where open / shut and bypass cases fell from 5.0% in 2007-2009 to 3.0% in 2013-2015 [1]. This success reflects improvements in staging, including the introduction of PET scanning, more availability and improved expertise in endo-oesophageal ultrasound (EUS), and the administration of neoadjuvant chemotherapy, given to over 67.1% of cases in 2013-2014 [1].

It is clear that upper GI surgery has taken over malignant oesophageal practice in most areas of the United Kingdom. Seven thoracic units performed over 10 resections in the period 2010-2015, and only one unit performed more than 5 minimally invasive resections. No minimally invasive resections were reported in the three years 2012-2013 to 2014-2015. In 2015, only 4 thoracic units (Nottingham, Liverpool, Coventry and Plymouth) performed more than ten resections for malignant disease by any approach.

Due to the limitations of the data gathered, it is not possible to determine whether thoracic surgeons are involved in either complex oesophageal cases with upper GI surgeons, or in the treatment of oesophageal perforation. Only Liverpool, Nottingham and Belfast reported fifty or more major benign cases in the five years 2010-2015 (Fig. 6.03).

Fig. 6.03 **Oesophagogastric surgery: Activity *per* unit; 2010-2015 (n=1,772)**



A decline in therapeutic oesophagoscopy in the registry mirrors the decline in the treatment of oesophageal malignancies by thoracic surgeons (Fig. 6.05). One would suspect that most of the procedures recorded are secondary to resections, or are palliative procedures for those not having curative surgery in the units performing oesophageal surgery. Oesophagoscopy remains more widespread than cancer resection, with 10 units reporting more than 50 procedures between 2010-2015.

National activity in thoracic surgery decreased from 463 to 294 oesophagoscopy procedures / year during the period of this review. Survival is generally 98-100%, though there was a surprising spike in mortality to 7% in 2013-2014, associated with an increased number of procedures in that year. This reverted to the previous trend in the following year. Survival in these cases is usually determined by the condition for which the procedure is being performed. Therefore, repeated procedures on a small number of patients who eventually died of their underlying condition may skew the data over a short time period.

Fig. 6.04 **Oesophagogastric resections for cancer: Activity; 2010-2015 (n=1,232)**

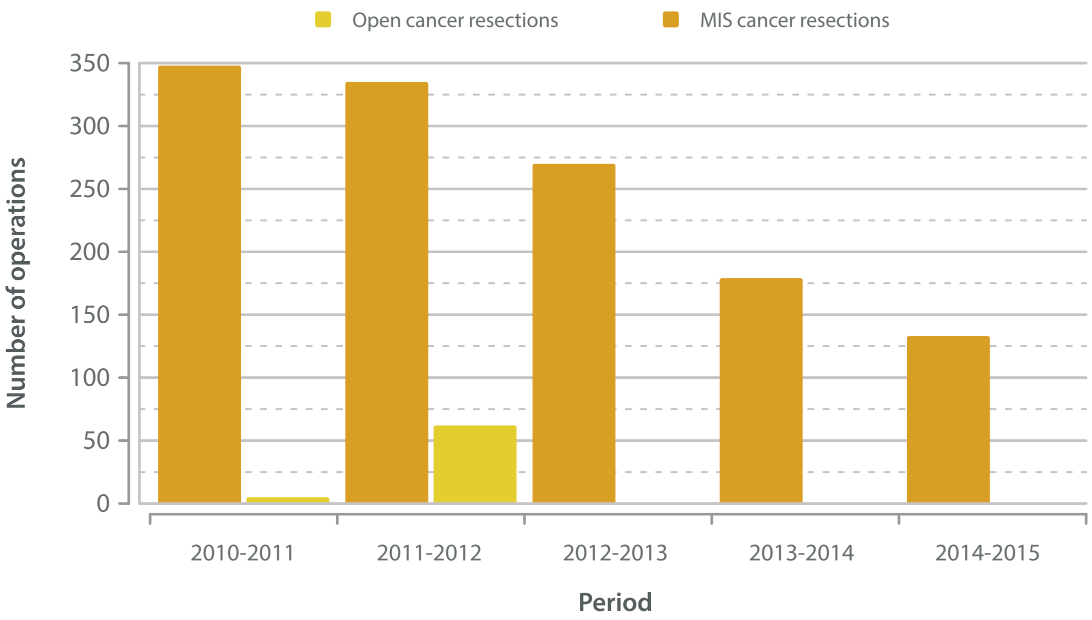
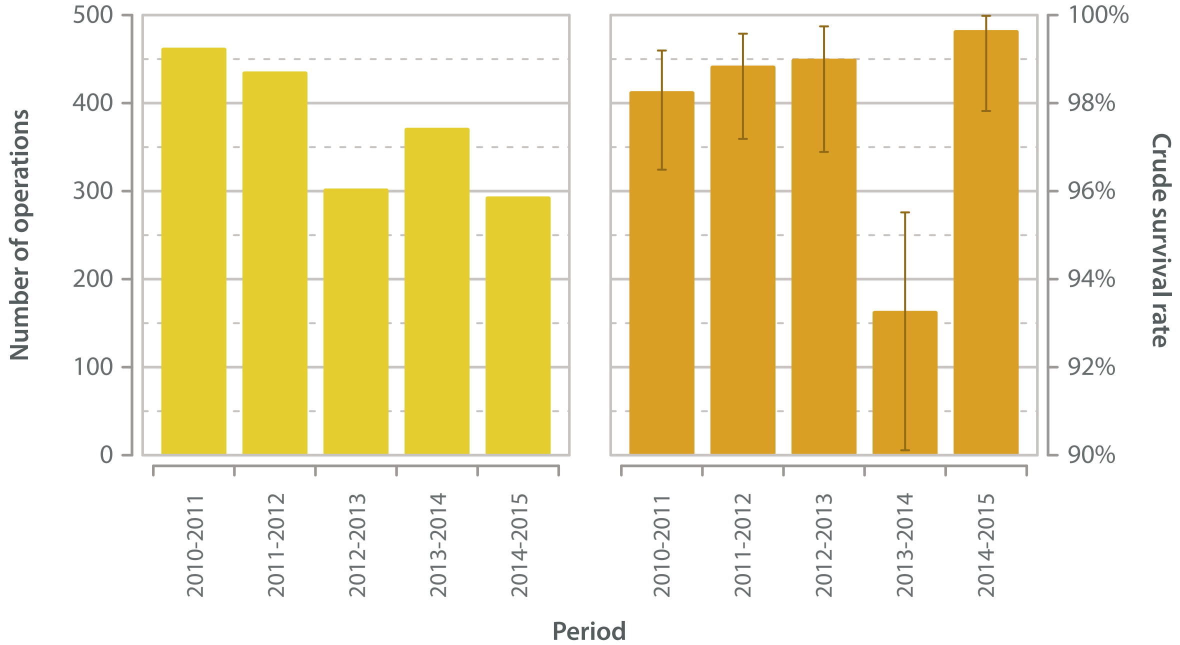


Fig. 6.05 **Therapeutic oesophagoscopy: Activity and survival to discharge 2010-2015 (n=1,868)**



Mediastinal surgery

Mediastinal procedures have broadly increased (Fig. 6.06 and Fig. 6.07), with VATS mediastinal tumour resections doubling from 90 cases in 2010-2011 to 197 in 2014-2015. The commonest named procedure was open thymectomy for thymoma. Myaesthenia gravis was the indication for 23.4% of all the open thymectomies performed (equivalent data for VATS thymectomy was not collected).

Fig. 6.06 **Open mediastinal surgery; 2010-2015 (n=3,415)**

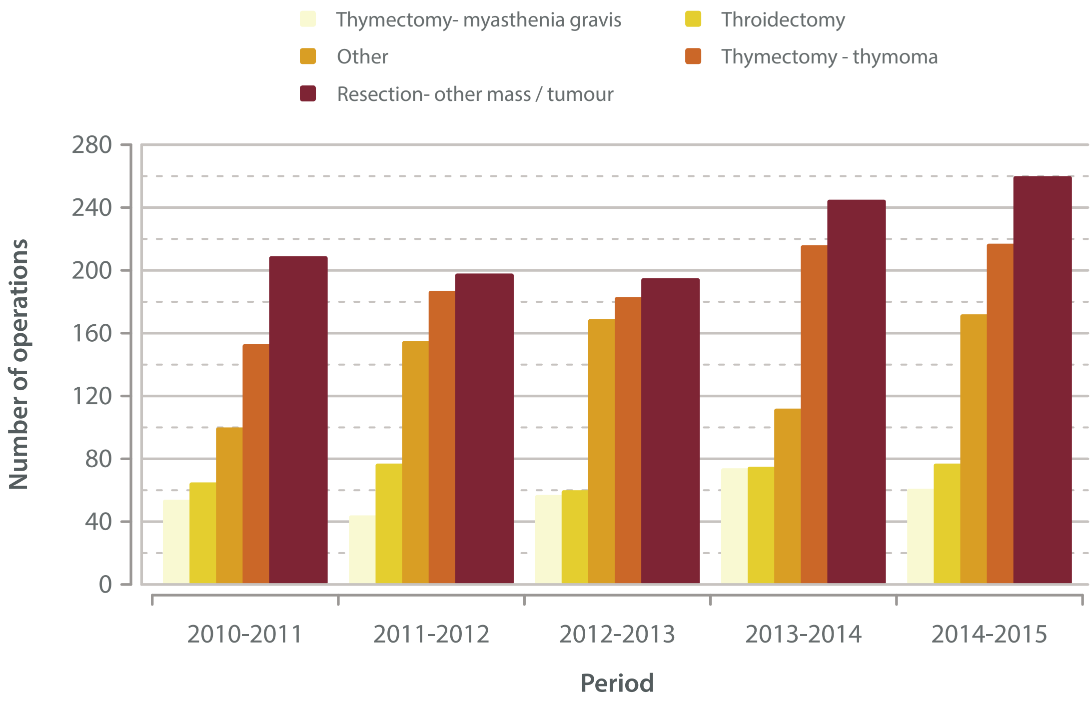
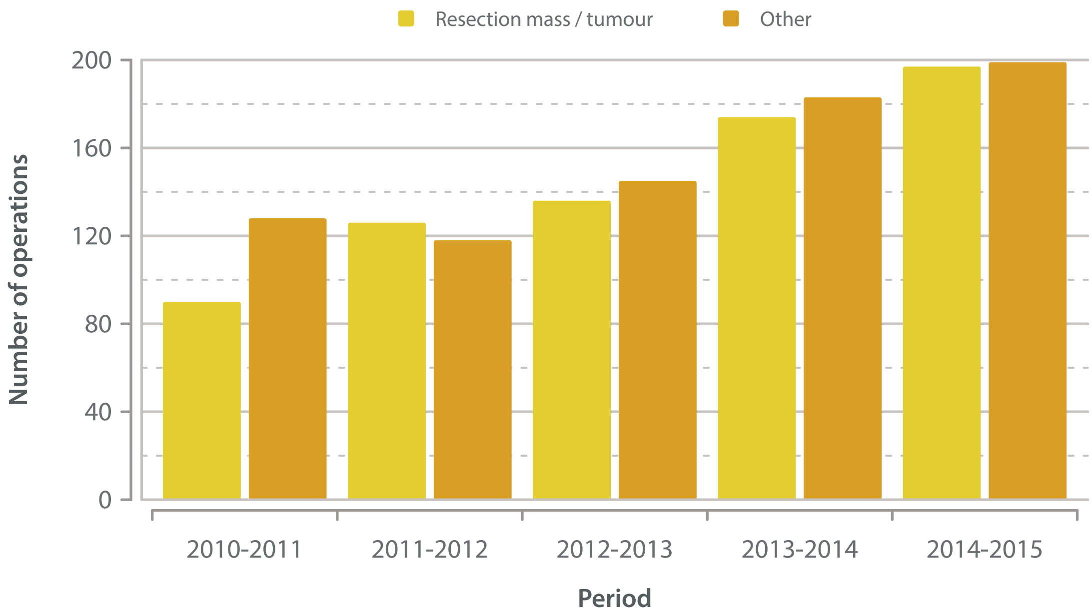


Fig. 6.07 **VATS mediastinal surgery; 2010-2015 (n=1,496)**



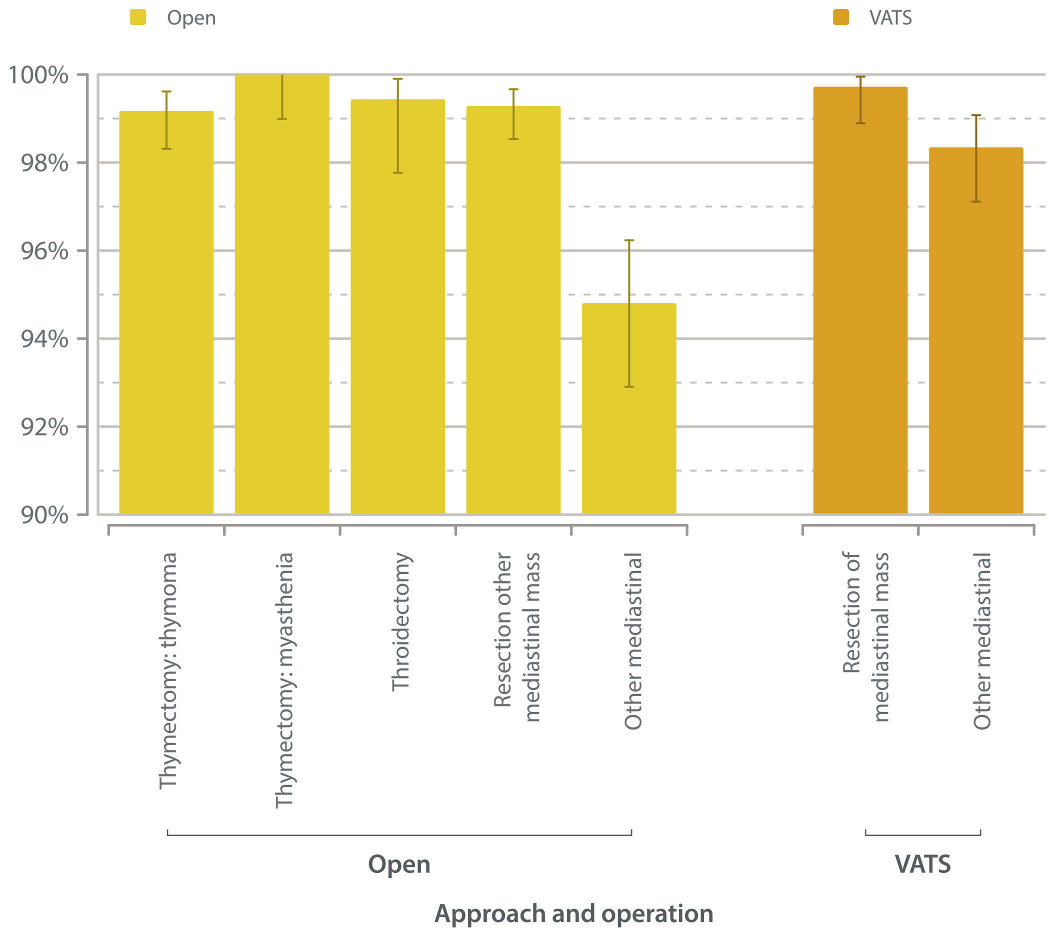
Mediastinal surgery is broadly safe, with all procedures except open and VATS *other* groups recording survival to discharge rates of over 99% (Fig. 6.08; Table 6.01). The *other* group includes surgery for mediastinal sepsis, a patient group with major pre-operative morbidity, which might account for the lower survival in this group. Mediastinal surgery is more widely spread across surgical units than oesophageal surgery (Fig. 6.10), and the majority of units performed >100 cases over the five year period reported.

Table 6.01 **Oesophageal and mediastinal surgery:** in-hospital outcome, approach and operation; 2010-205

			In-hospital outcome			
			Survival	**Death**	**All**	**Survival rate**
Oesophageal surgery	**Open**	OR [i] or bypass for cancer	1,235	30	1,265	97.6%
		OR [i] or bypass for non-malignant disease	88	1	89	98.9%
		Other major oesophagogastric	366	12	378	96.8%
		Exploration only (open / close)	79	3	82	96.3%
		Minor oesophageal	193	3	196	98.5%
	VATS	Therapeutic cancer resection	65	2	67	97.0%
		Diagnostic oesophagogastric	142	0	142	100.0%
		Therapeutic - other	42	1	43	97.7%
Mediastinal surgery	**Open**	Thymectomy for thymoma	961	8	969	99.2%
		Thymectomy for myasthenia gravis	296	0	296	100.0%
		Thyroidectomy	353	2	355	99.4%
		Resection of other mediastinal mass or tumour	1,102	8	1,110	99.3%
		Mediastinoscopy or mediastinotomy	11,508	46	11,554	99.6%
		Other mediastinal procedures	673	39	712	94.5%
	VATS	Resection of mediastinal mass or tumour	721	2	723	99.7%
		Other mediastinal procedures	760	13	773	98.3%

i. Oesphagogastric resection

Fig. 6.08 **Mediastinal surgery: Survival to discharge; 2010-2015 (n=4,939)**



Mediastinoscopy and mediastinotomy remains a common procedure group, but activity in 2014-2015 was down by 35.1% on 2010-2011 levels. The increasing use of endobronchial ultrasound transbronchial needle aspirate (EBUS-TBNA) and endoscopic ultrasound (EUS) in both diagnosis of mediastinal lymphadenopathy and staging of lung cancer is likely to be at least partly responsible.

Fig. 6.09

Mediastinoscopy & mediastinotomy: Activity; 2010-2015 (n=11,554)

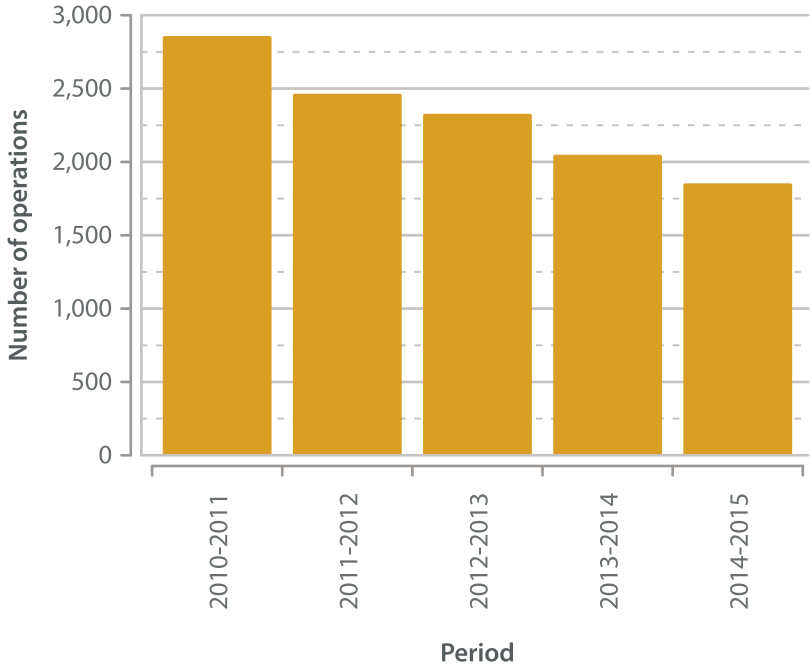
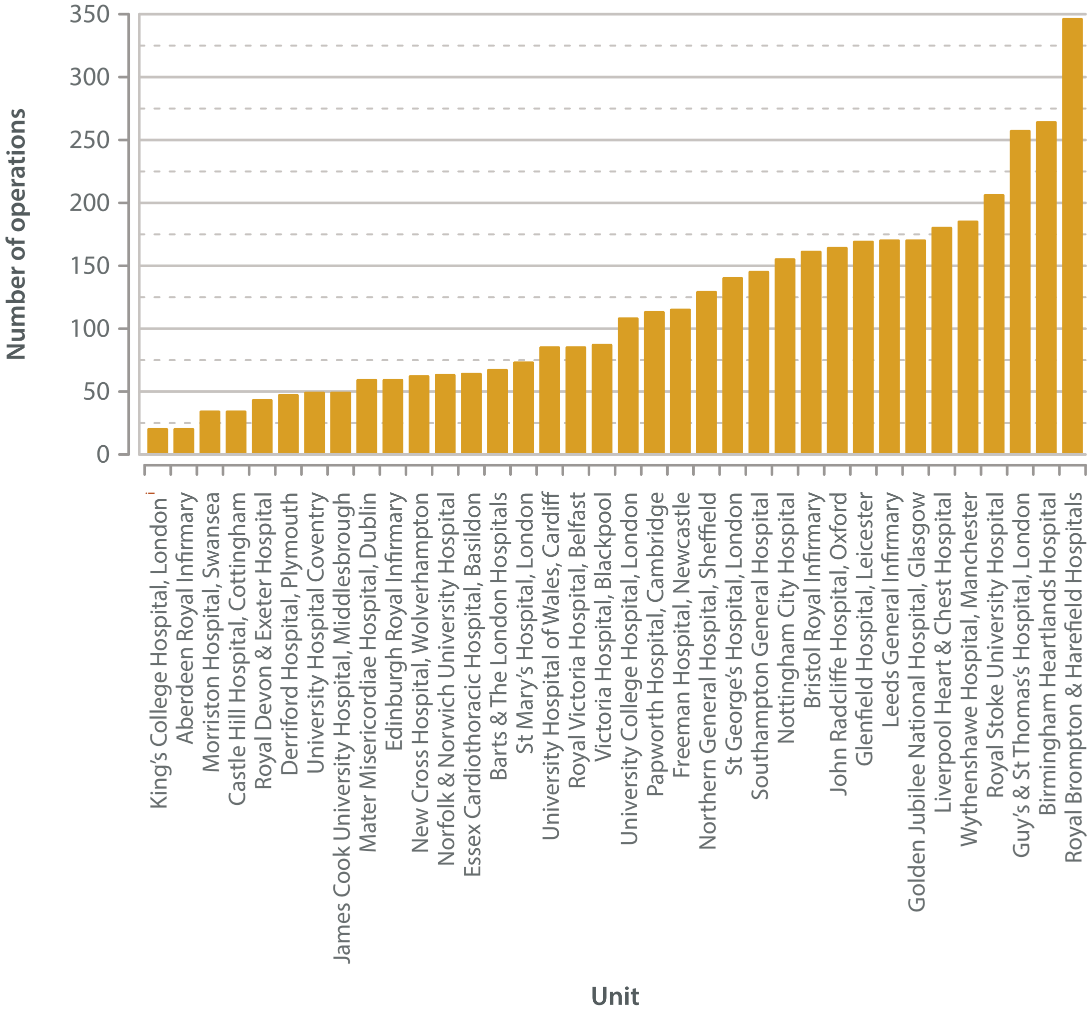


Fig. 6.10 **Mediastinal surgery excluding mediastinoscopy / mediastinotomy: Activity *per* unit; 2010-2015 (=4,213)**



i. Centres did not submit data for every year in the defined analysis period.

References

1. National oesophaogastric cancer audit 2016, Healthcare Quality Improvement Partnership https://digital.nhs.uk/catalogue/PUB21561.
2. A policy framework for commissioning cancer services: A report by the Expert Advisory Group on Cancer to the Chief Medical Officers of England and Wales ("the Calman-Hine report") http://webarchive.nationalarchives.gov.uk/20080817211349/http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4071083.
3. WH Allum, JM Blazeby, SM Griffin, D Cunningham, JA Jankowski, R Wong Guidelines for the management of oesophageal and gastric cancer. *Gut*. 2011; **60(11)**: 1449-72.
4. EP van Vilet, MH Heijenbrok-Kal, MG Hunink, EJ Kuipers, PD Siersema. Staging investigations for oesophageal cancer: a meta-analysis. *British Journal of Cancer*. 2008; **98(3)**: 547-57

Section 2

The thoracic surgical database project 2014-2017

Chapter 7: The Thoracic Database

The development of the SCTS thoracic database

This section of the report covers the SCTS database, a three-year national audit project in adult general thoracic surgery in Britain and Ireland that began in 2014 and closed in 2017.

The SCTS database was made possible by a grant to the Society from the UK General Medical Council. It was managed by Dendrite Clinical Systems, on behalf of the Society.

The Society ran a database prior to the GMC grant, and we reported its contents in our Second National Thoracic Surgery Activity and Outcomes Report in 2011. A data dictionary was agreed in 2002. By 2011, 12 of what were then 41 United Kingdom and Irish units (29%) had contributed data.

Over the period 2006-2010 18,301 lung cancer operations were reported to the SCTS registry, but only 3,583 were reported in the database, 19.6% of the cases submitted to the registry during the same period. We speculated on possible reasons for this low level of submission to the database in our 2011 report. Lack of data infrastructure in departments of thoracic surgery, potentially competing projects such as the National Lung Cancer Audit, and possibly concerns about the effects of surgeon-specific reporting in cardiac surgery and other specialties may all have had a role in limiting submissions to the database.

The GMC began revalidating doctors in 2012. Around this time the reporting of surgical outcomes, pioneered in cardiac surgery by the SCTS, was gaining widespread acceptance across surgical specialties. The GMC agreed to fund the Society to deliver a thoracic surgery database, with the aim of publicly reporting thoracic surgical outcomes, supporting surgeons with revalidation, facilitating service improvement and clinical research, and reassuring stakeholders about the quality of care delivered.

The new database used the previously agreed SCTS data dictionary (Appendix 3). It was developed and managed by Dendrite Clinical Systems. It allowed uploads in two ways; by individual surgeons inputting data directly, or by whole-unit uploads for departments capable of this. This design allowed surgeons whose units did not have well developed internal databases to contribute to the national database.

Duration and coverage of the database

The database collected data for three financial years; 2014-2015, 2015-2016 and 2016-2017. It stopped collecting data in April 2017. During this period, 14 hospitals, or about 36% of all the public hospitals performing adult thoracic surgery in the United Kingdom and Ireland submitted data. All participating hospitals were in England. The data reported therefore represents a minority of the activity in the country, as reported through the SCTS register.

Because of the uploading structure described above, the data included here is not necessarily the entire activity for the units covered. Some units had surgeons who were uploading data *via* the portal, while their colleagues were not submitting. Similarly, some surgeons only submitted data for part of the three years covered by the database.

Closure of the database

The database closed in 2017. There were several reasons for this. Firstly, the Lung Cancer Consultant (later Clinical) Outcomes Publication (LCCOP) issued its first report in 2014. LCCOP is a national audit of lung cancer surgery outcomes in England, commissioned by the Healthcare Quality Improvement Partnership (HQIP) for NHS England, as part of the wider Clinical Outcomes Publication (https://www.hqip.org.uk/national-programmes/clinical-outcomes-publication/). Although LCCOP only covers lung cancer resection surgery in England, the validation of data required for LCCOP competed with the SCTS database for units' resources and time, contributing to the decline seen in submissions to the database as the project went on (Table 7.01). Once units were contributing to national audit through LCCOP, the onus on them to contribute to the SCTS database declined. Lastly, the database required multiple data points *per* patient, including details of the operation and the final pathology, which required two separate data entries for each patient. For surgeons using the individual patient upload portal, this placed heavy demands on their time.

In the final year of the project, the GMC confirmed that funding would be limited to three years. The Society wanted to simplify audit requirements for clinical units, and so decided to support the LCCOP project and the SCTS register, while discontinuing the SCTS thoracic database.

The LCCOP project design minimises the need for extensive data entry by clinicians, by using routinely collected NHS data sources including the Cancer Outcomes and Services Dataset (COSD) and the Hospital Episode Statistics (HES). Clinicians are required to validate only a limited dataset for each patient, and the need for primary data entry by clinicians is avoided.

Nature and limitations of the SCTS thoracic database

The history of the database project as outlined above defines its nature and usefulness today. It includes activity from a large group of thoracic surgery units within the English NHS, over a three-year period from 2014 to early 2017. It has extensive peri-operative data on the patients involved, including pre-operative investigations and peri-operative details, for a variety of both benign and cancer operations. It does not include patient identifiable data, making it impossible to link to other NHS data sources. The data for individual units is not necessarily complete, since several units only had a subset of their surgeons submitting to the project.

The 12 units that submitted some data tended to be larger than those that did not submit. Judged by their SCTS returns for 2010-2015 (excluding endoscopy), submitting units performed 888 cases *per* year, while non-submitters performed 579 case *per* year* (p 0.005).

The final data is therefore useful in identifying general trends in outcomes and activity, and in providing in-depth data on a large subset of patients undergoing thoracic surgery in the United Kingdom. Because it does not include data from a majority of units, and the data on submitting units is incomplete, it should not be used to draw comparisons between units or individual clinicians.

Outlier analysis in the SCTS thoracic database

Because only a minority of units submitted to the SCTS database, and because HQIP's LCCOP programme audits a large amount of the same activity, we have not formally identified outliers in the SCTS returns.

Instead, we have reported unadjusted data, and we ask units simply to reflect on their own data in comparison to national pooled results. This is in contrast to the LCCOP project, where the Society supports the identification and support of outliers on adjusted survival outcomes.

Important differences between the database project and the SCTS register returns

When reading this report, it is important to bear in mind the differences between the SCTS register in section 1 and the SCTS database here. The database covers surgery in a minority of units, all in England, over a three-year period. In several of these units, not all activity was uploaded to the database. The register by contrast has enjoyed near-complete submission rates across the United Kingdom and Ireland, but only includes data on units activity and in hospital mortality.

Uncommon statistical measures

The box-and-whisker plots shown later in this section use a number of well-known statistical measures of spread to provide a visual representation of a distribution: the median, surrounded by the lower and upper quartiles (the inter-quartile range, or IQR); this is the middle portion of the rank-ordered numbers in the distribution, in which half of all the numerical values fall.

There are two more measures of spread that describe the more extreme ends of the distribution: the lower and upper adjacents. Formally, these values are determined as:

- lower adjacent: the smallest observation that is **greater** than or equal to the Lower Inner Fence (LIF) value; the LIF = lower quartile - [1.5 × IQR]
- upper adjacent: the largest observation that is **less** than or equal to the Upper Inner Fence (UIF) value; the UIF = upper quartile + [1.5 × IQR]

i. Analysis after excluding units with incomplete **SCTS** returns data for 2010-2015.

Overall activity

10,235 cases were submitted in total in the financial years 2014-2016.

Table 7.01 Overall activity recorded

		Database entries
Financial year	2014	3,660
	2015	4,335
	2016	2,240
	All	**10,235**

Table 7.02 Operative priority; financial years 2014-2016

		Count	Percentage
Operative priority	Elective	7,537	74.2%
	Urgent	2,425	23.9%
	Emergency	193	1.9%
	Unspecified	80	
	All	**10,235**	

Table 7.03 Surgical strategy; financial years 2014-2016

		Count	Percentage
Surgical strategy	Diagnostic	4,581	44.8%
	Staging or assessment	1,297	12.7%
	Therapeutic	7,521	73.6%
	None recorded	14	
	All	**10,235**	

Fig. 7.01

Thoracic surgical database: Pathological category (n=10,215)

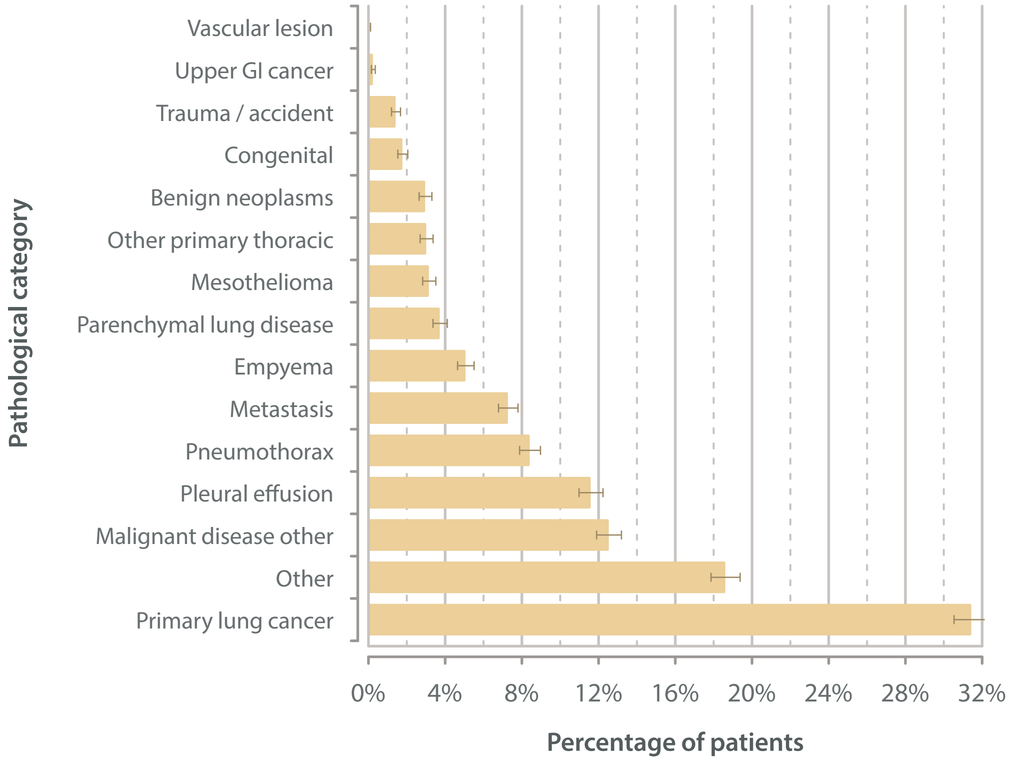


Fig. 7.02

Thoracic surgical database: Primary organ / system targeted (n=10,215)

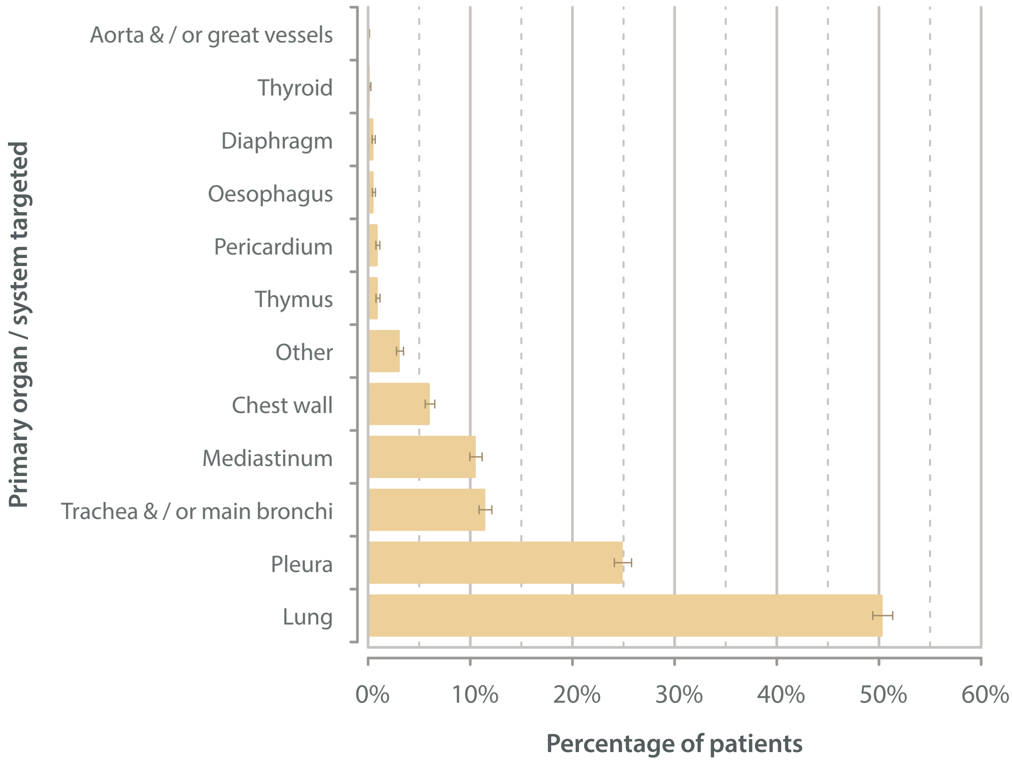


Table 7.04 Comorbidity

		Comorbidity status			
		No	Yes	Unspecified	Rate where known
Comorbidity	Insulin dependent diabetes	8,003	292	1,940	3.5%
	Ischaemic heart disease	7,590	918	1,727	10.8%
	Cardiac failure	8,242	164	1,829	2.0%
	Previous stroke	8,304	383	1,548	4.4%
	Steroid therapy	7,911	446	1,878	5.3%
	Anticoagulation	7,822	517	1,896	6.2%
	Previous history of cancer	5,807	2,392	2,036	29.2%
	Hypertension	5,760	2,744	1,731	32.3%
	Peripheral vascular disease	7,720	520	1,995	6.3%
ASA grade	ASA grade 1	7,038	1,699	1,498	19.4%
	ASA grade 2	4,859	3,878	1,498	44.4%
	ASA grade 3	5,905	2,832	1,498	32.4%
	ASA grade 4	5,637	3,100	1,498	35.5%
	ASA grade 5	8,719	18	1,498	0.2%

Fig. 7.03 **Thoracic surgical database: Named operations (n=10,215)**

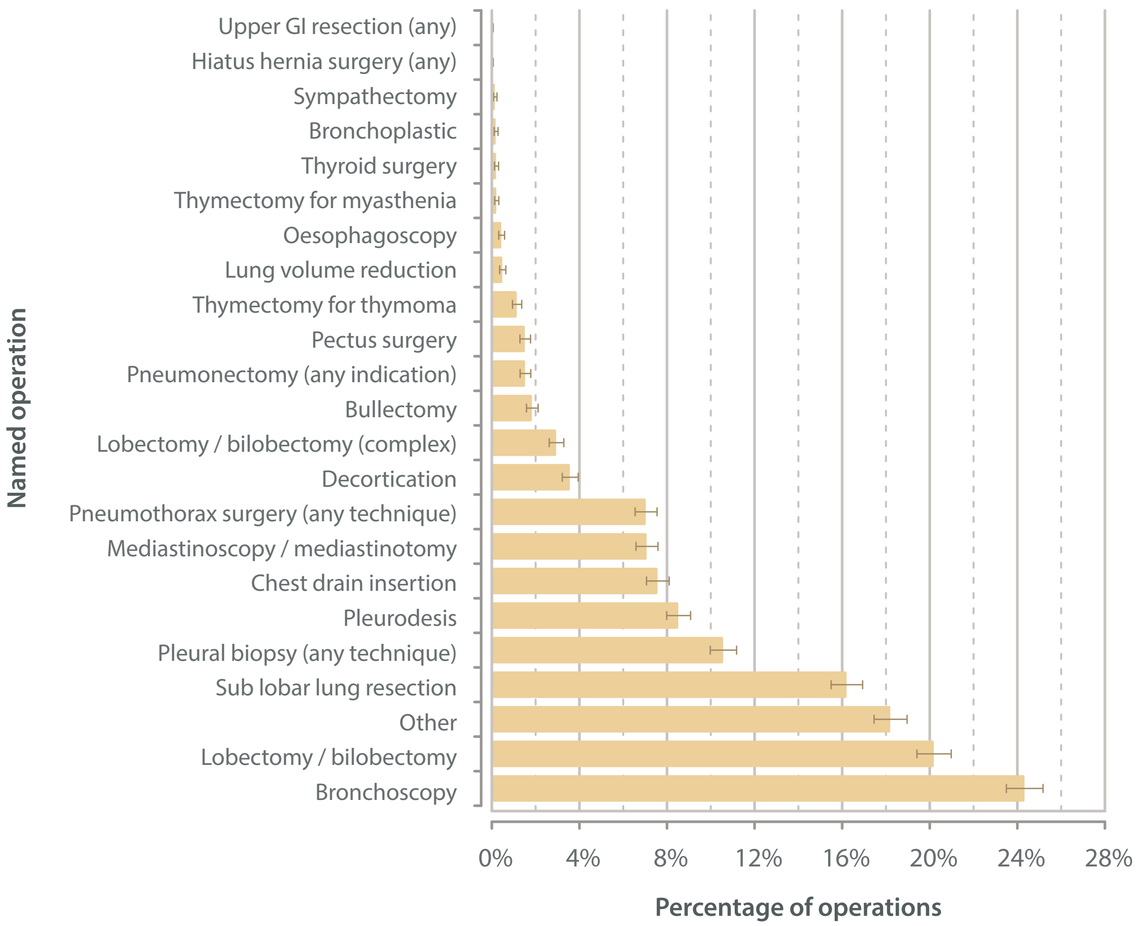


Table 7.05 Complications and length of stay for each named operation

Named operations	Count	Median post-operative stay / days	In hospital survival	Air leak	Infection prolonging hospital stay	Unplanned ICU readmission
	Complications and post-operative stay data					
Bronchoplastic	18	5.0 (n=15)	100.0% (n=15)	0.0% (n=14)	7.1% (n=14)	0.0% (n=14)
Bronchoscopy	2,485	3.0 (n=2,372)	98.0% (n=2,378)	3.0% (n=2,266)	1.3% (n=2,268)	0.4% (n=2,270)
Bullectomy	187	5.0 (n=178)	100.0% (n=178)	8.8% (n=159)	3.7% (n=159)	0.6% (n=159)
Chest drain insertion	773	4.0 (n=680)	97.9% (n=682)	1.8% (n=637)	2.3% (n=637)	0.1% (n=640)
Decortication	364	6.0 (n=335)	98.5% (n=335)	6.0% (n=264)	5.6% (n=265)	1.8% (n=268)
Hiatus hernia surgery (any)	1	3.0 (n=1)	100.0% (n=1)	0.0% (n=1)	0.0% (n=1)	0.0% (n=1)
Lobectomy / bilobectomy	2,062	5.0 (n=1,943)	98.5% (n=1,954)	13.0% (n=1,660)	7.4% (n=1,560)	4.0% (n=1,668)
Lobectomy / bilobectomy (complex)	300	7.0 (n=288)	98.6% (n=289)	5.8% (n=256)	4.7% (n=251)	6.2% (n=257)
Lung volume reduction	49	7.0 (n=46)	95.6% (n=46)	21.0% (n=38)	2.6% (n=38)	0.0% (n=38)
Mediastinoscopy / mediastinotomy	722	0.0 (n=678)	99.7% (n=679)	0.4% (n=611)	0.9% (n=611)	0.4% (n=611)
Oesophagoscopy	44	1.0 (n=43)	100.0% (n=43)	0.0% (n=43)	0.0% (n=43)	0.0% (n=43)
Pectus surgery	154	4.0 (n=146)	100.0% (n=146)	0.0% (n=94)	1.0% (n=94)	0.0% (n=94)
Pleural biopsy (any technique)	1,079	3.0 (n=1,000)	98.9% (n=1,002)	2.0% (n=860)	2.9% (n=861)	0.8% (n=864)
Pleurodesis	870	4.0 (n=824)	98.3% (n=823)	3.3% (n=571)	2.4% (n=572)	1.2% (n=576)
Pneumonectomy (any indication)	155	7.0 (n=144)	94.5% (n=146)	0.0% (n=127)	9.4% (n=116)	4.6% (n=129)
Pneumothorax surgery (any technique)	718	4.0 (n=688)	99.5% (n=689)	6.9% (n=562)	1.7% (n=562)	1.0% (n=565)
Sublobar lung resection	1,655	4.0 (n=1,531)	99.7% (n=1,532)	4.4% (n=1,210)	3.0% (n=1,205)	1.6% (n=1,217)
Sympathectomy	14	1.0 (n=14)	100.0% (n=14)	0.0% (n=12)	0.0% (n=12)	0.0% (n=12)
Thymectomy for myasthenia	21	4.5 (n=20)	100.0% (n=20)	0.0% (n=16)	0.0% (n=16)	0.0% (n=16)
Thymectomy for thymoma	116	4.0 (n=106)	100.0% (n=106)	0.0% (n=88)	3.4% (n=88)	2.2% (n=88)
Thyroid surgery	20	4.5 (n=20)	100.0% (n=20)	0.0% (n=17)	0.0% (n=17)	0.0% (n=17)
Upper GI resection (any)	1	48.0 (n=1)	100.0% (n=1)	0.0% (n=1)	0.0% (n=1)	0.0% (n=1)
Other	1,859	3.0 (n=1,733)	97.9% (n=1,740)	2.7% (n=1,547)	4.1% (n=1,550)	1.6% (n=1,554)

Surgery for primary lung cancer

2,931 lung cancer resections were reported to the database, with numbers reported falling slowly over the course of the project (Fig. 7.04, Table 7.06). All contributing units were based in England, and we believe that competition with the Lung Cancer Clinical (previously Consultant) Outcomes Publication (LCCOP) in England was an important factor in reducing data submission during this time. LCCOP produced its first national report in 2014.

Fig. 7.04 **Primary resections for lung cancer: Entries in the database (n=2,931)**

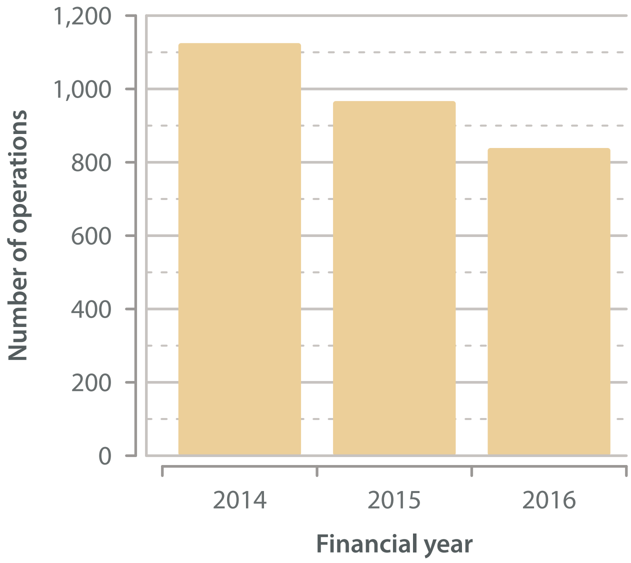


Fig. 7.05 **Primary resections for lung cancer: Number of entries; financial years 2014-2016 (n=2,931)**

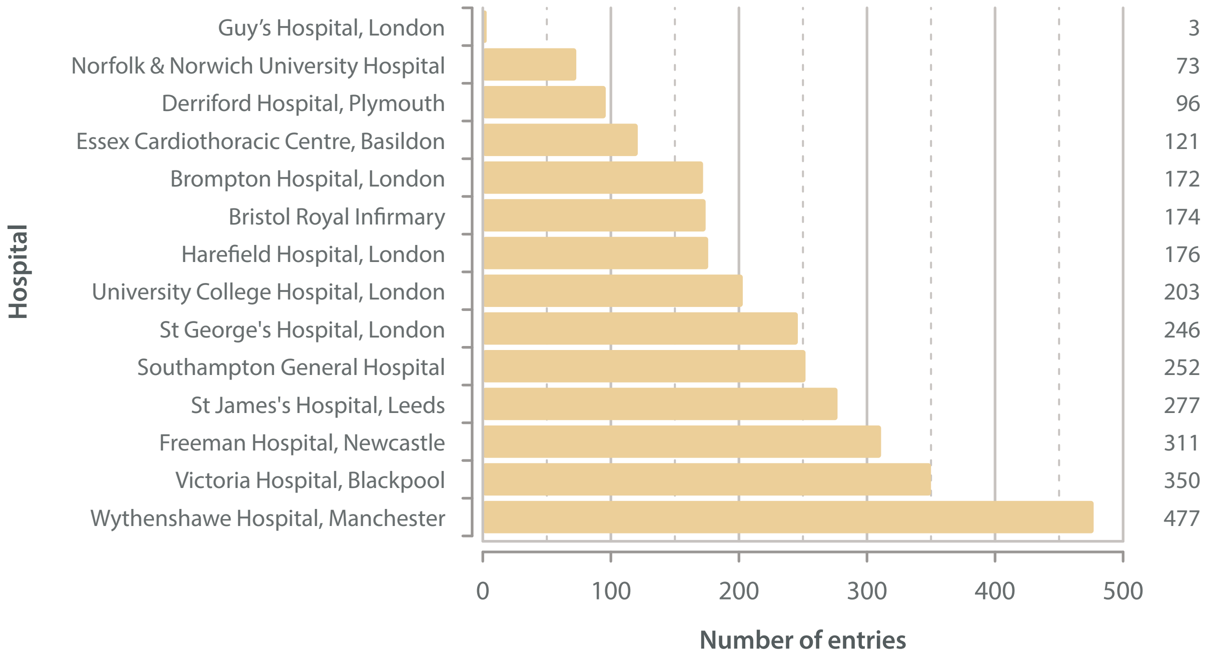


Table 7.06 **Primary resections for lung cancer:** number of entries at each hospital

Hospital	Financial year ending 2014	2015	2016	All
Guy's Hospital, London	3	0	0	**3**
Norfolk & Norwich University Hospital	63	10	0	**73**
Derriford Hospital, Plymouth	31	45	20	**96**
Essex Cardiothoracic Centre, Basildon	0	0	121	**121**
Brompton Hospital, London	0	172	0	**172**
Bristol Royal Infirmary	1	132	41	**174**
Harefield Hospital, London	0	176	0	**176**
University College Hospital, London	151	52	0	**203**
St George's Hospital, London	85	75	86	**246**
Southampton General Hospital	2	48	202	**252**
St James's Hospital, Leeds	0	0	277	**277**
Freeman Hospital, Newcastle	140	92	79	**311**
Victoria Hospital ,Blackpool	172	165	13	**350**
Wythenshawe Hospital, Manchester	477	0	0	**477**
All	**1,125**	**967**	**839**	**2,931**

Age and gender

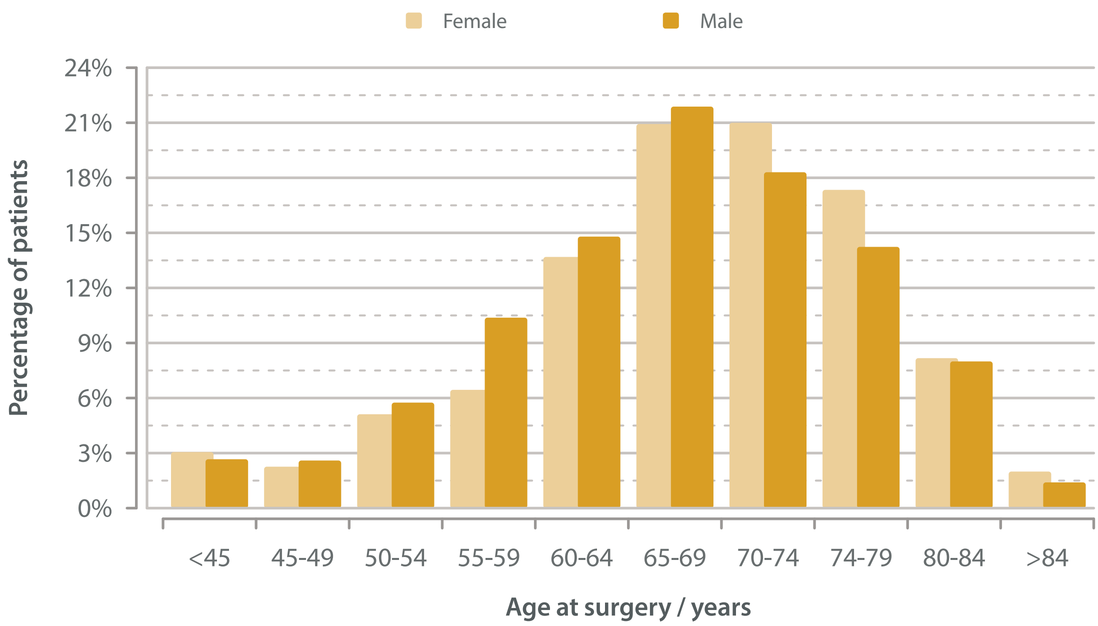
The modal age group was 65-69 years, with 26% of patients aged 75 or more (Table 7.07).

There was a slight preponderance of male patients (1,505 of 2,931, 51%). Interestingly, this male preponderance affected the younger age groups only. In all age bands from 45-49 to 65-69 males predominated, but in age groups older than 69, females were more common (Fig. 7.06, Table 7.07).

Table 7.07 **Primary resections for lung cancer:** age and gender; financial years 2014-2016

Age at surgery / years	Gender: Male	Gender: Female	Gender: All
<45	46	38	**84**
45-49	34	37	**71**
50-54	77	82	**159**
55-59	97	148	**245**
60-64	206	211	**417**
65-69	315	312	**627**
70-74	316	261	**577**
75-79	261	203	**464**
80-84	123	114	**237**
>84	30	20	**50**
All	**1,505**	**1,426**	**2,931**

Fig. 7.06 **Primary resections for lung cancer: Age and gender; financial years 2014-2016**



Thoracoscore

We attempted to calculate the Thoracoscore for patients within the database. Unfortunately, high levels of missing data, particularly the alcohol abuse question (data point 102, Appendix 3), meant that it was not possible to accurately produce this score.

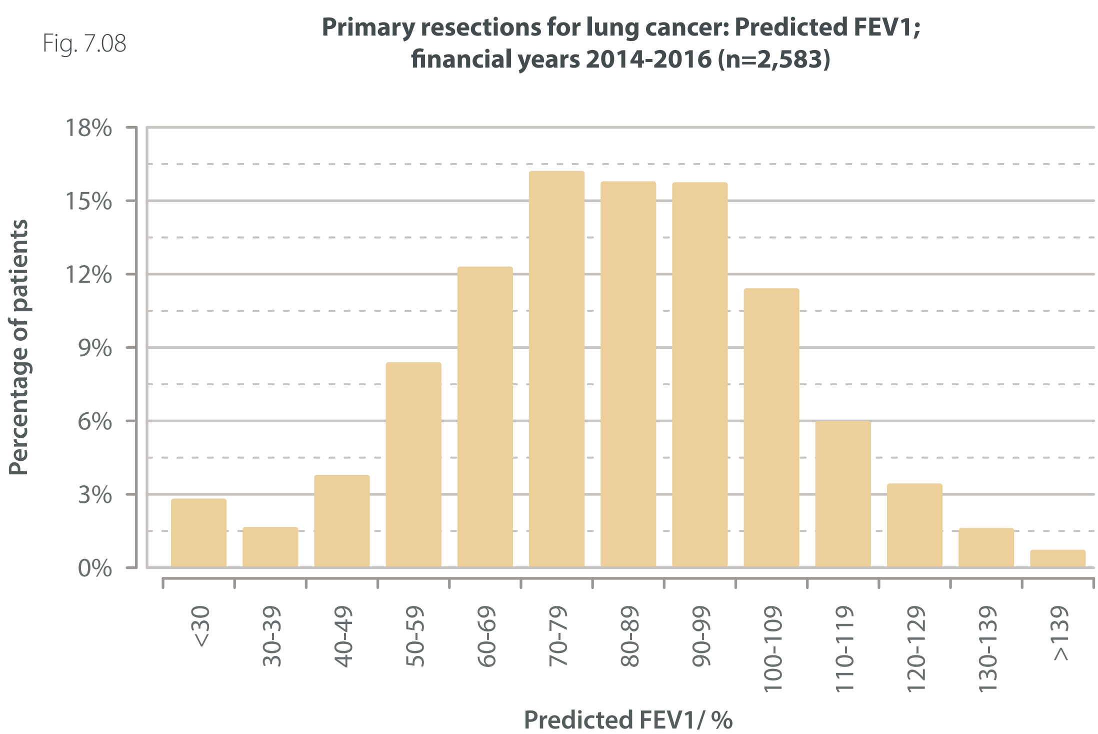
Predicted Forced Expiratory Volume in one second

Forced Expiratory Volume in one second (FEV1) was recorded in nearly 90% of patients (table 7.04). 45% of patients had a pre-operative FEV1 of less than 80% predicted. This is important, since 80% is one of two thresholds suggested by the ESTS / ERS guidelines as an indication for exercise testing before surgery, the other being a diffusing capacity of the lungs for carbon monoxide (DLCO) of 80% or less [1]. If units follow the ESTS / ERS guidelines, they will need the capacity to provide exercise testing for almost half of all patients, based on the FEV1 criteria alone.

Table 7.08 **Primary resections for lung cancer:** predicted FEV1; financial years 2014-2016

Predicted FEV1 / %	Count	Percentage
<30	73	2.8%
30-39	43	1.7%
40-49	98	3.8%
50-59	217	8.4%
60-69	318	12.3%
70-79	419	16.2%
80-89	408	15.8%
90-99	407	15.8%
100-109	295	11.4%
110-119	155	6.0%
120-129	89	3.4%
130-139	42	1.6%
>139	19	0.7%
Unspecified	348	
All	**2,931**	

Fig. 7.08



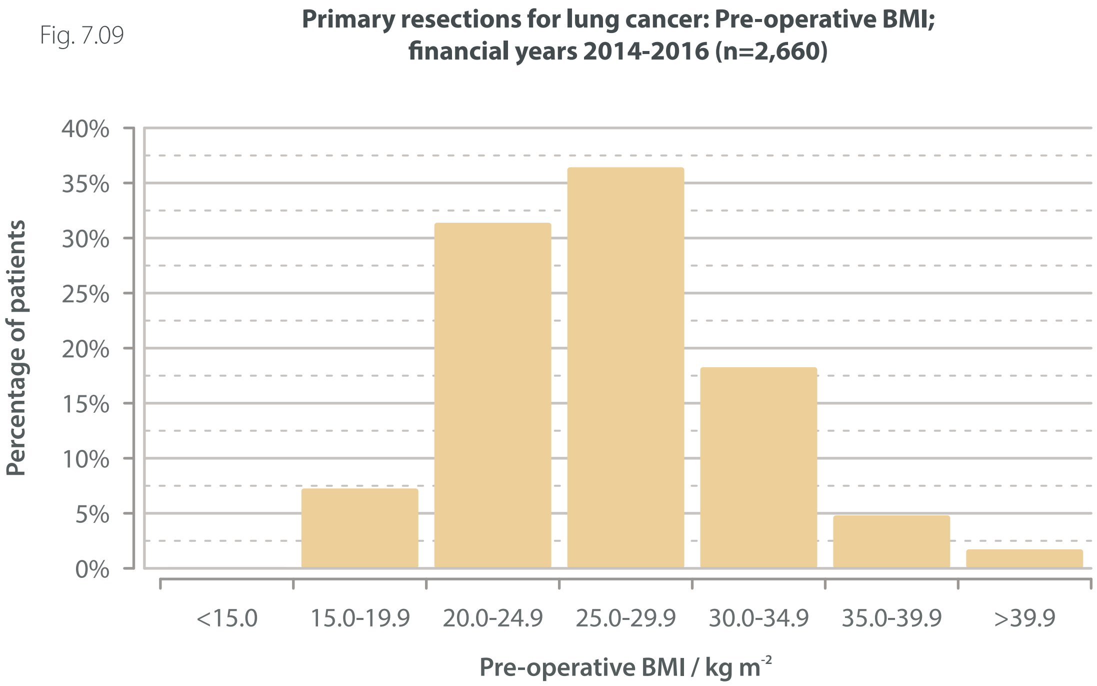
Body mass index

The majority of patients had a body mass index (BMI) above 25 kg m^{-2}, the usual definition of overweight, and 24.8% had a BMI above 30 kg m^{-2}, usually defined as obese (Fig. 7.09, Table 7.09). Higher BMI has been associated with improved survival after lung resection [2].

Table 7.09 **Primary resections for lung cancer:** pre-operative body mass index; financial years 2014-2016

BMI / kg m^{-2}	Count	Percentage
<15.0	3	0.1%
15.0-19.9	193	7.3%
20.0-24.9	835	31.4%
25.0-29.9	969	36.4%
30.0-34.9	486	18.3%
35.0-39.9	128	4.8%
>39.9	46	1.7%
Unspecified	271	
All	**2,931**	

Fig. 7.09

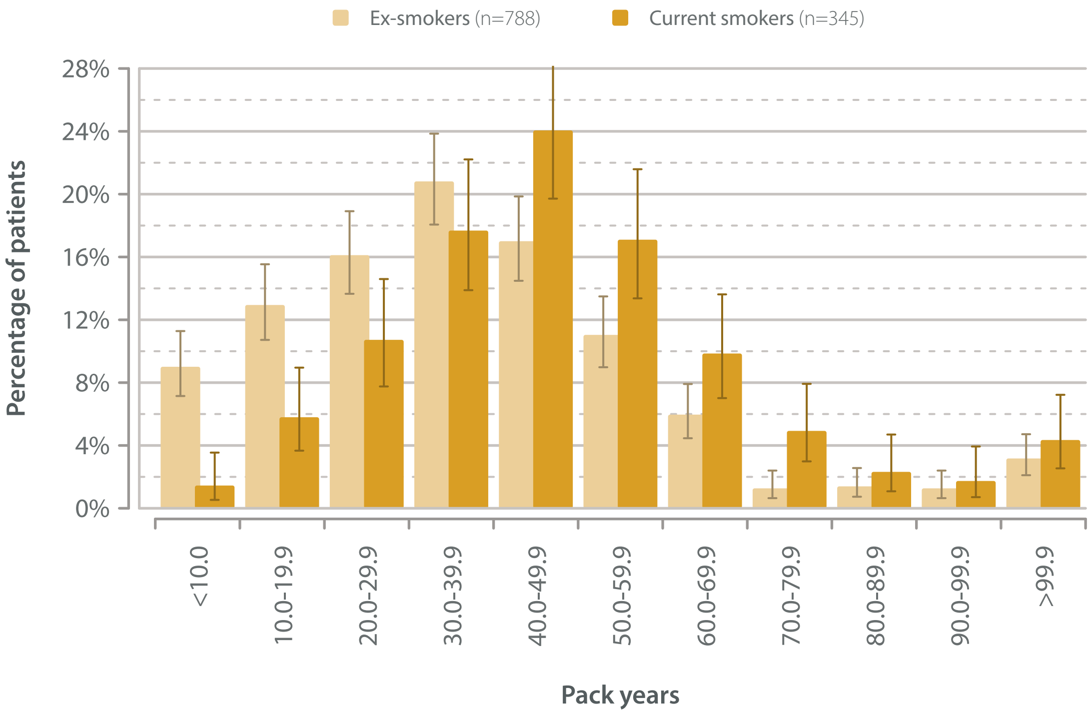


Smoking history

412 / 2,784 have never smoked (missing data = 147); 14.8%

Fig. 7.10

Primary resections for lung cancer: Smoking history and pack years; financial years 2014-2016 (n=1,133)



Pre-operative patient flow

The 2011 NICE issued guidance on the diagnosis and management of lung cancer (CG121), recommending FDG-PET scanning in all patients being considered for lung cancer surgery [3]. Compliance with this guidance was high at 93% in 2014, rising progressively to nearly 99% by 2016 (Fig. 7.11), although there was some variation between units (Fig. 7.12).

Fig. 7.11

Primary resections for lung cancer: Utilisation of PET; financial years 2014-2016 (n=2,700)

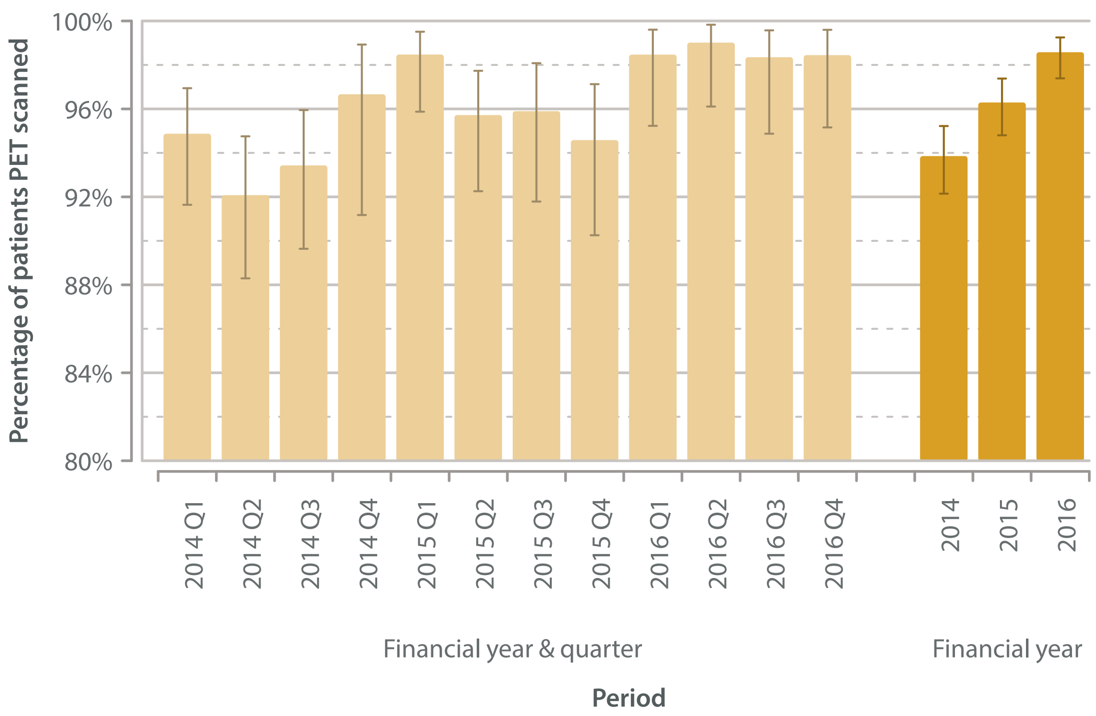
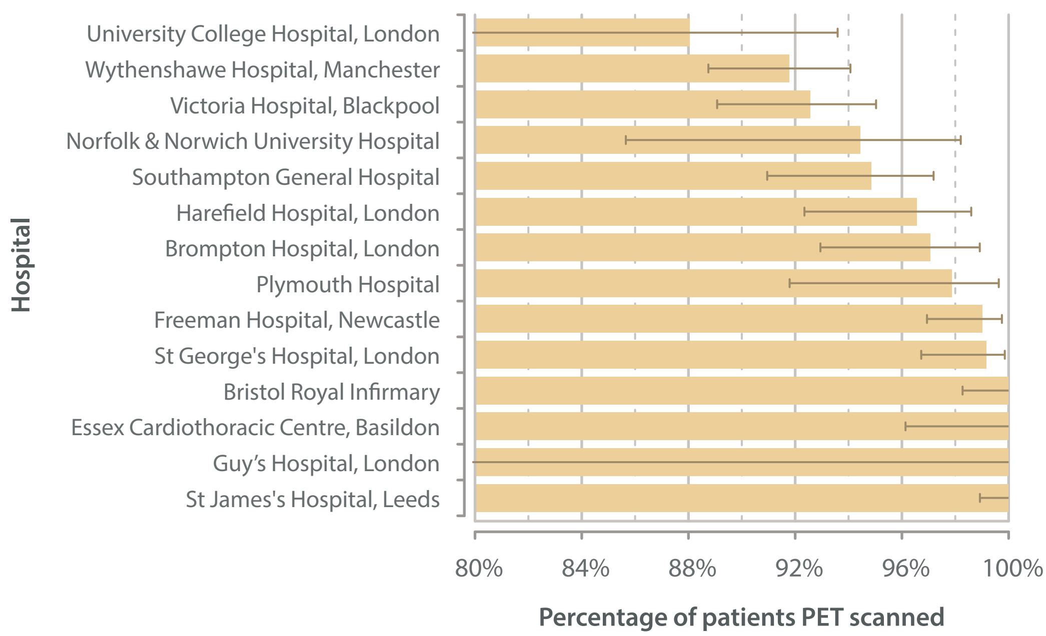


Fig. 7.12

Primary resections for lung cancer: Utilisation of PET; financial years 2014-2016 (n=2,700)

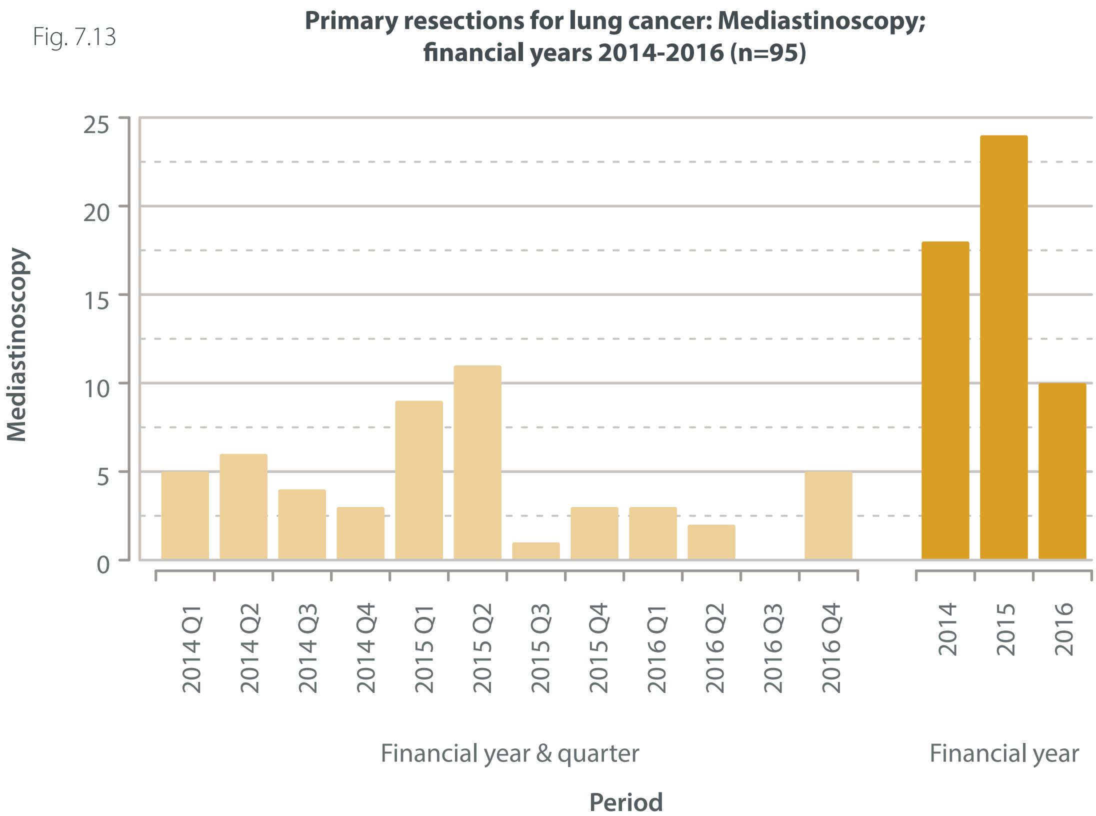


Mediastinoscopy

Mediastinoscopy procedures allow the biopsy of mediastinal lymph nodes, and is often performed to stage or diagnose primary lung cancer before surgical resection of their lung cancer. Some of these patients are not being considered for surgical resection, but require tissue in order to plan oncological therapies. Others will be assessed for resection, but their mediastinoscopy shows that their tumour is too advanced for surgery to be effective.

The number of mediastinoscopy procedures performed have, been falling as less invasive staging procedures like endobronchial ultrasound guided transbronchial biopsy (EBUS-TBNA) and endoscopic ultrasound (EUS) have entered routine clinical practice.

Fig. 7.13



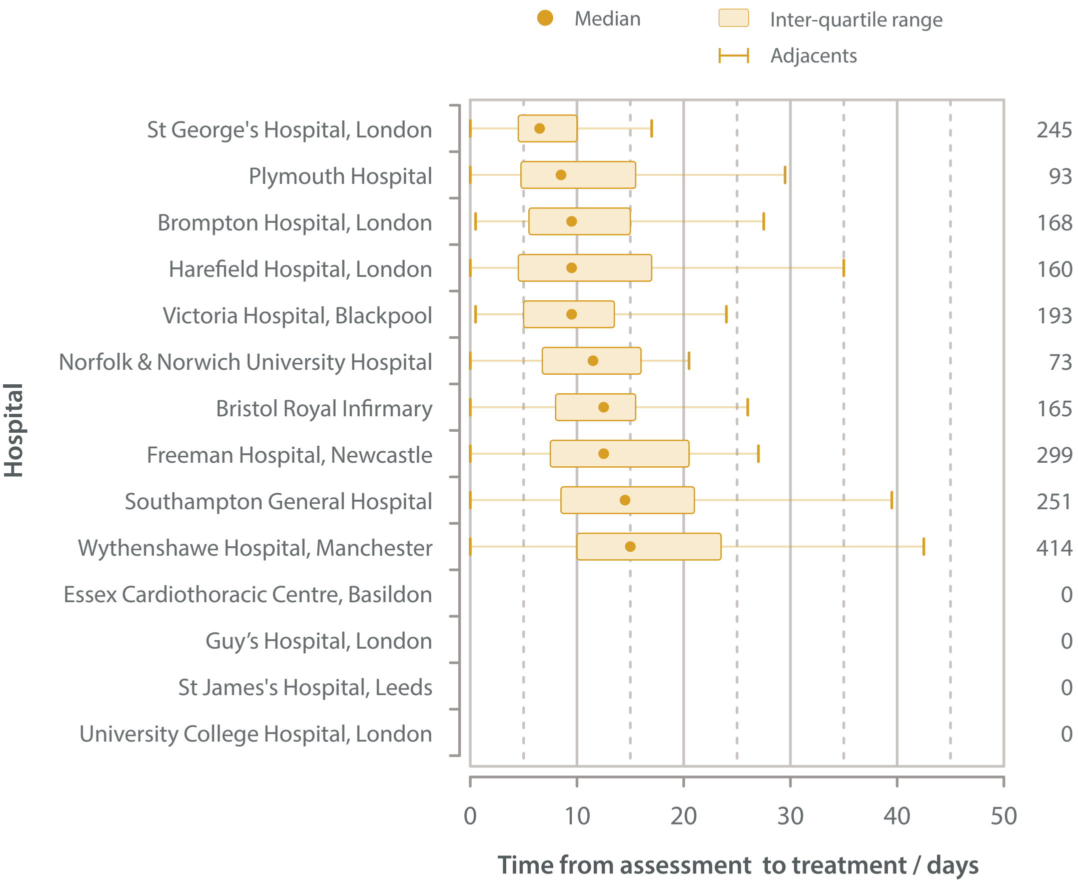
Time from referral to surgical assessment

NHS England operated a 62-day target from initial GP referral to commencing treatment for cancer during the time period of the SCTS database, and a 31-day target from the decision to treat to treatment commencing. For surgical therapies, commencing treatment was defined as undergoing surgical resection. There has been evidence in recent years that the NHS has struggled to meet these targets (https://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2017/06/Cancer-Waiting-Times-Annual-Report-201617-1.pdf).

We did not directly collect data on the NHS's 31- or 62-day target, but time from surgical referral, to the date of starting surgical treatment was recorded (Fig. 7.14). There was relatively little variation between units with median wait times ranging around 10 days, although some patients did wait longer than 31 days.

Fig. 7.14

Primary resections for lung cancer: Time from referral to treatment; financial years 2014-2016 (n=2,061)



Surprisingly, the answer to a second question in the database, the time from referral to surgical assessment, was very similar from the time to treatment (Fig. 7.15). It may be that the units involved admitted patients very quickly after clinic assessment, or that they counted the admission date for surgery as the date of first assessment.

Fig. 7.15 **Primary resections for lung cancer: Time from referral to surgical assessment; financial years 2014-2016 (n=1,965)**

Intra-operative care

Frozen section rate = 26.6%; diagnosis = 24.4%. 73.4% of patients did not require intra-operative frozen section. Of the 26.6% who did, the great majority were to confirm the diagnosis, with only 2.2% of all patients having a frozen section purely to stage their disease.

Table 7.10 **Primary resections for lung cancer:** frozen section taken as surgical resection; financial years 2014-2016

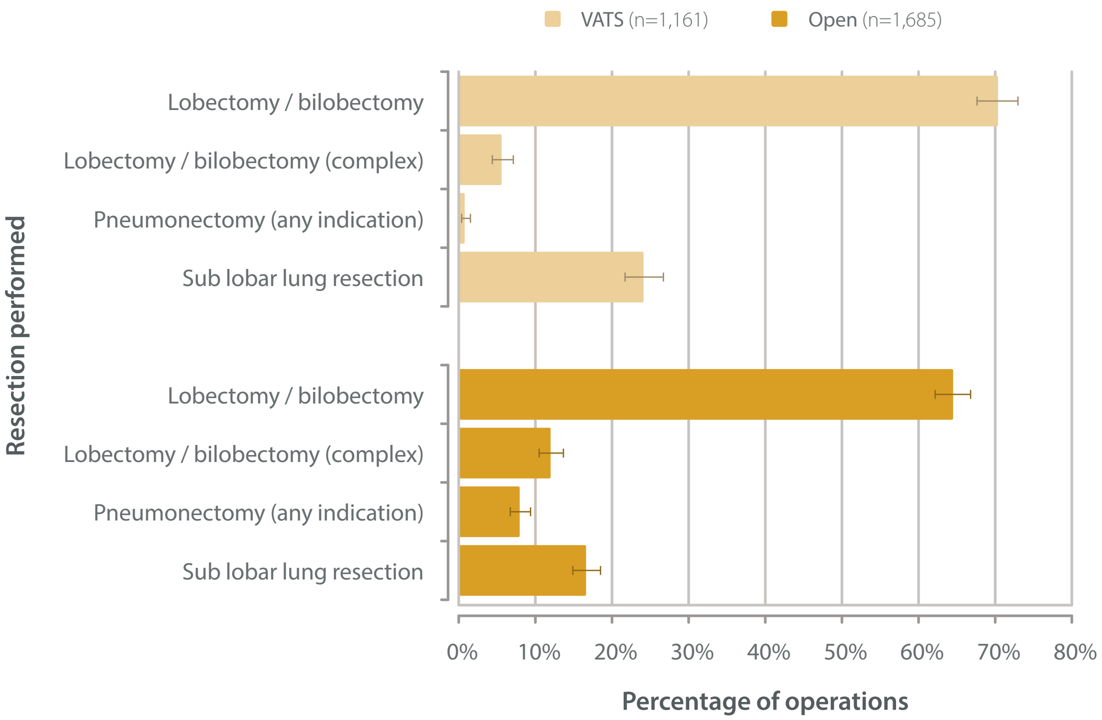
		Count	Percentage
Frozen section taken	No	1,927	73.4%
	Diagnosis	619	23.6%
	Staging	57	2.2%
	Diagnosis & staging	22	0.8%
	Unspecified	306	
	All	**2,931**	

The most commonly performed resections for lung cancer were lobectomy or bilobectomy procedures. Only 5.1% of recorded resections were pneumonectomy procedures. This is in keeping with current NICE guidance, which recommends lobectomy as the procedure of choice for most lung cancer patients who are fit to undergo it.

Table 7.11 **Primary resections for lung cancer:** named operations and surgical approach; financial years 2014-2016

Named operation	Counts			Percentages		
	VATS	Open	All	VATS	Open	All
Lobectomy / bilobectomy	817	1,087	1,865	70.4%	64.5%	66.6%
Lobectomy / bilobectomy (complex)	65	202	267	5.6%	12.0%	9.5%
Pneumonectomy (any indication)	9	134	142	0.8%	8.0%	5.1%
Sub lobar lung resection	280	280	551	24.1%	16.6%	19.7%
No resection recorded	15	39	131			
Operation count	**1,176**	**1,724**	**2,931**			

Fig. 7.16 **Primary resections for lung cancer: Resection; financial years 2014-2016**



During the audit period the IASLC 7th edition of the TNM staging system was used. While cT3 and cT4 disease accounted for nearly 1 in 5 cases, cN2 disease was much less common, with fewer than 5% of patients having clinical evidence of mediastinal node involvement.

Fig. 7.17 **Primary resections for lung cancer: TNM staging; financial years 2014-2016**

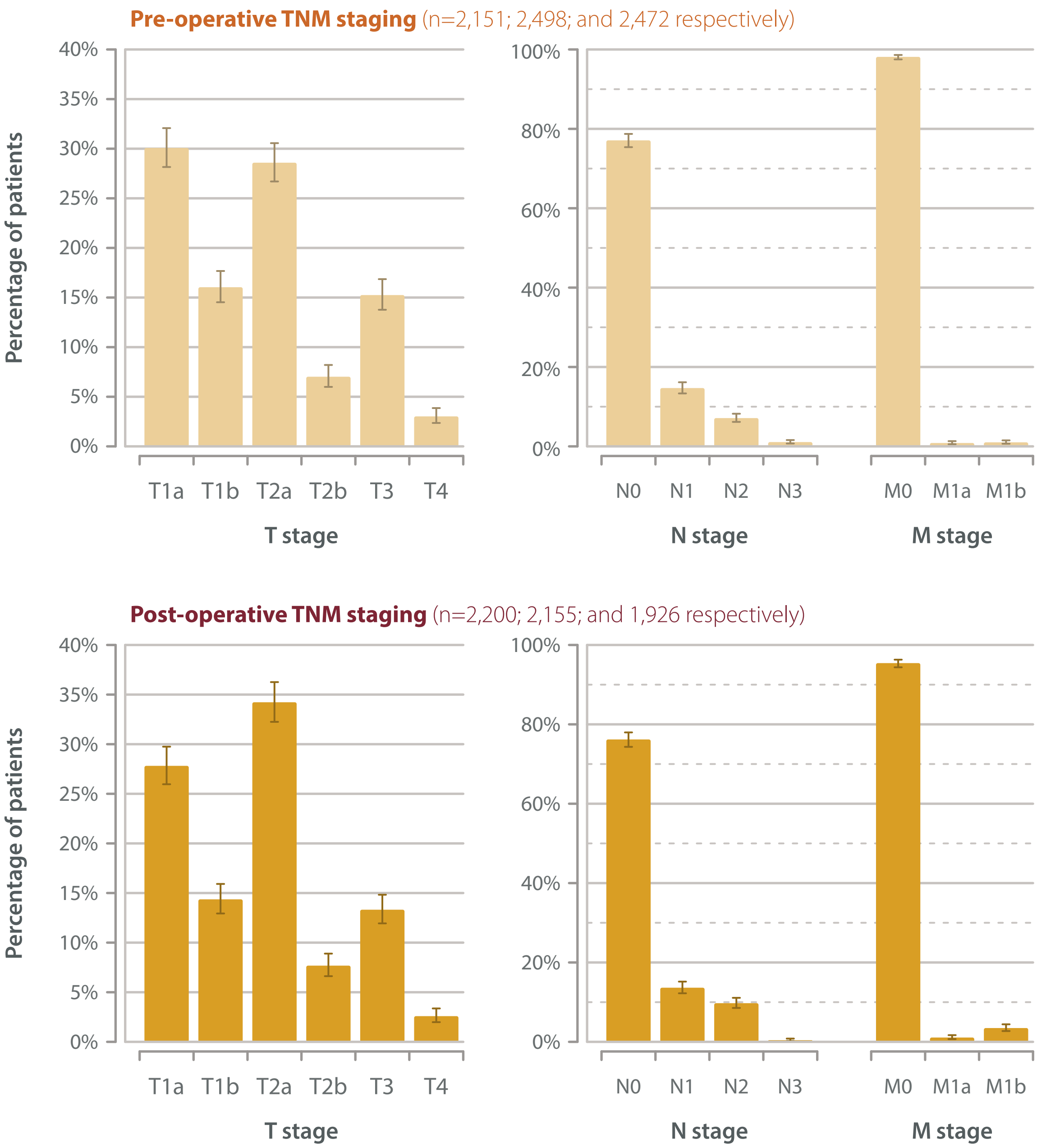


Fig. 7.18 **Primary resections for lung cancer: Pre-operative and post-operative TNM stage; financial years 2014-2016**

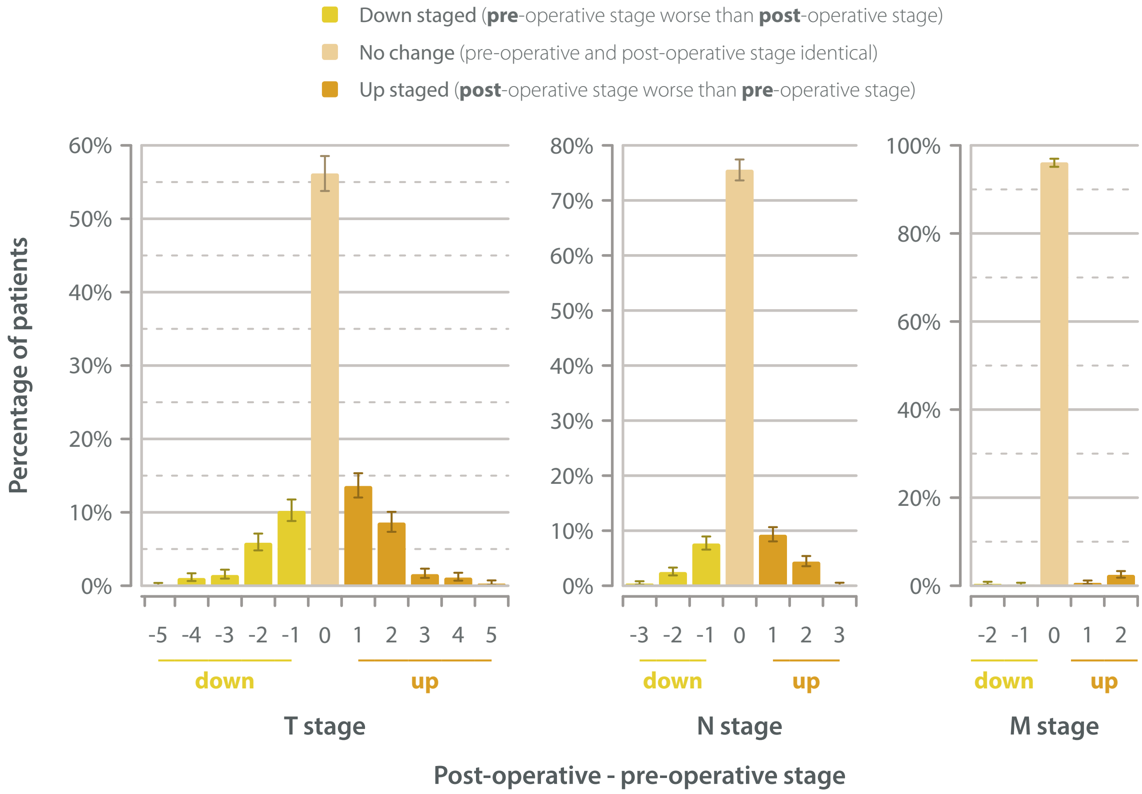
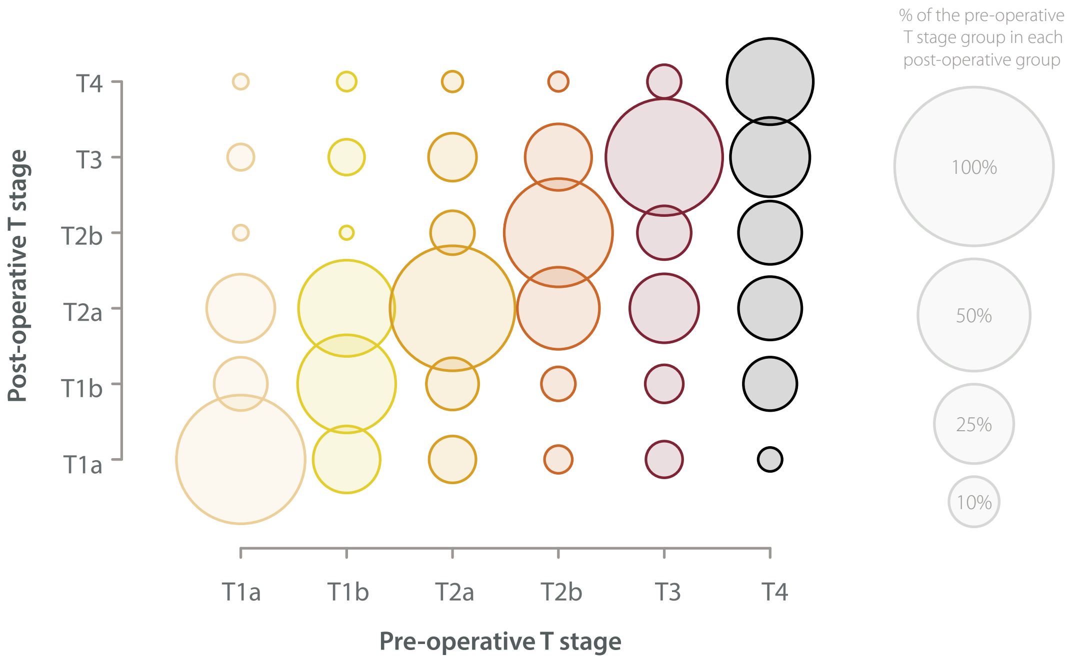


Fig. 7.19 **Primary resections for lung cancer: Pre-operative and post-operative T stage; financial years 2014-2016 (n=1,707)**



Post-operative stay

Median length of stay for individual units varied between 4 and 10 days, with a pooled median of 5 days for submitting units (Table 7.12). Length of stay for English NHS units in 2014 and 2015 has been reported in the LCCOP reports for these years (https://scts.org/lccop/), with pooled national medians of 6 days seen in both 2015 and 2014. It is reassuring that the LCCOP data, which is derived from routinely collected NHS Hospital Episode Statistics (HES) data, shows good correlation with the SCTS database data from the same period, although the data sources were separate. The recently released Getting it Right First Time (GIRFT) report for cardiothoracic has supported day of surgery admission as a strategy to reduce length of stay for planned chest surgery (http://gettingitrightfirsttime.co.uk/cardiothoracic-surgery-report).

Fig. 7.20

Primary resections for lung cancer: Post-operative stay; financial years 2014-2016 (n=1,812)

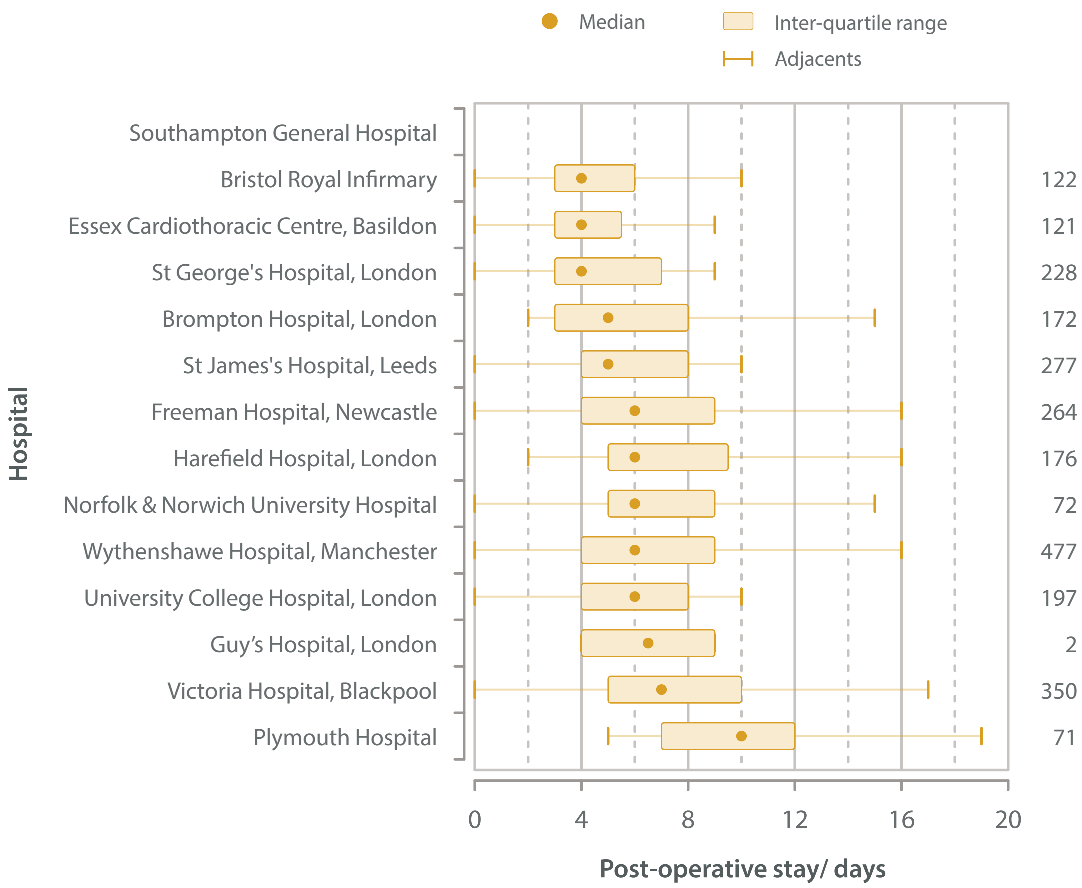


Table 7.12 **Primary resections for lung cancer:** post-operative stay statistics; financial years 2014-2016

Hospital	Post-operative stay statistics / days					
	LA	**Q1**	**Median**	**Q3**	**UA**	**Count**
Bristol Royal Infirmary	0.0	3.0	4.0	6.0	10.0	122
Brompton Hospital, London	2.0	3.0	5.0	8.0	15.0	172
Essex Cardiothoracic Centre, Basildon	0.0	3.0	4.0	5.5	9.0	121
Freeman Hospital, Newcastle	0.0	4.0	6.0	9.0	16.0	264
Guy's Hospital, London	4.0	4.0	6.5	9.0	9.0	2
Harefield Hospital, London	2.0	5.0	6.0	9.5	16.0	176
Norfolk & Norwich University Hospital	0.0	5.0	6.0	9.0	15.0	72
Derriford Hospital, Plymouth	5.0	7.0	10.0	12.0	19.0	71
Wythenshawe Hospital, Manchester	0.0	4.0	6.0	9.0	16.0	477
Southampton General Hospital						
St George's Hospital, London	0.0	3.0	4.0	7.0	9.0	228
St James's Hospital, Leeds	0.0	4.0	5.0	8.0	10.0	277
University College Hospital, London	0.0	4.0	6.0	8.0	10.0	197
Victoria Hospital, Blackpool	0.0	5.0	7.0	10.0	17.0	350
All	**0.0**	**3.5**	**5.0**	**8.0**	**14.0**	**2,778**

LA = lower adjacent; **Q1** = lower quartile; **Q3** = upper quartile; **UA**= Upper adjacent

Complications

The data dictionary (see Appendix 3) recorded five peri-operative complications: return to theatre during the same admission, air leak beyond five days post-operatively, return to intensive care, requirement for intermittent positive-pressure ventilation (IPPV) and infection prolonging hospital stay. It was also possible to positively identify patients as not experiencing a complication.

Overall, 76.2% of patients did not experience a complication (Table 7.13). However, variation between units was high, with several units outside unadjusted 99.8% confidence intervals (Fig. 7.21). The commonest complication was air leak, affecting 10.5% of patients. Return to theatre was less common, with 2.3% of all patients experiencing this event. Again there were units outside the 99.8% confidence interval. These data could reflect local practice differences in the management of air leak, bronchoscopy for sputum retention and VATS for retained haemothorax, or they could reflect differences in the actual rate of primary complications between units.

Table 7.13 **Primary resections for lung cancer:** complications; financial years 2014-2016

	Post-operative complications data					
	Complication-free		Prolonged air leak		Return to theatre	
Hospital[i]	Count	Rate	Count	Rate	Count	Rate
Bristol Royal Infirmary	125	82.4%	123	7.3%	124	1.6%
Brompton Hospital, London	172	82.6%	172	5.2%	172	3.5%
Freeman Hospital, Newcastle	269	59.5%	268	12.7%	269	5.9%
Guy's Hospital, London	2	100.0%	2	0.0%	2	0.0%
Harefield Hospital, London	176	88.1%	176	4.0%	176	2.3%
Norfolk & Norwich University Hospital	72	63.9%	72	9.7%	72	5.6%
Derriford Hospital, Plymouth	74	75.7%	72	8.3%	72	5.6%
Wythenshawe Hospital, Manchester	477	80.5%	477	9.0%	477	0.8%
Southampton General Hospital	137	82.5%	134	10.4%	135	0.7%
St George's Hospital, London	229	79.9%	229	14.4%	229	0.9%
St James's Hospital, Leeds	277	57.8%	277	23.8%	277	1.4%
Victoria Hospital, Blackpool	350	84.3%	350	5.1%	350	1.7%
All	**2,360**	**76.2%**	**2,352**	**10.5%**	**2,355**	**2.3%**

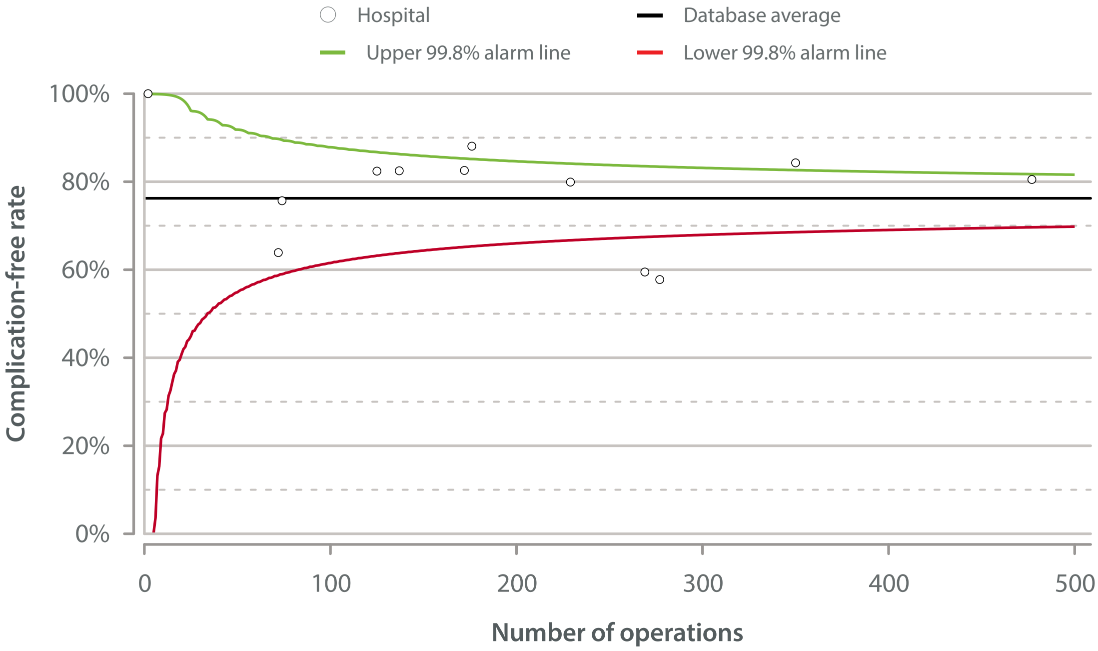
Any complications

The overall complication rates after cancer resection are shown in the funnel plot Fig. 7.21. There was variation seen outside the 99.8% confidence intervals. These data are not adjusted for any differences in case mix between units. Nearly four patients in five do not experience an in-hospital complication after lung cancer surgery.

i. No data received from Essex Cardiothoracic Centre, Basildon & University College Hospital, London.

Fig. 7.21

Primary resections for lung cancer: Complication-free rates; financial years 2014-2016 (n=2,360)

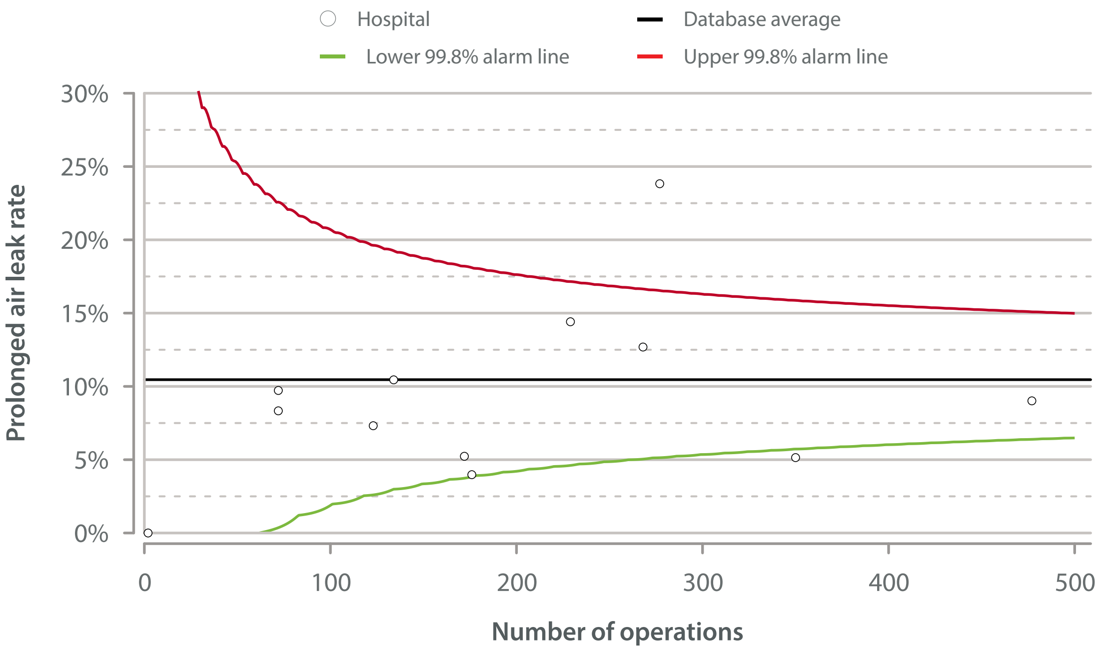


Prolonged air leak

Prolonged air leak was defined in the data dictionary (Appendix 3) as persisting beyond the seventh post-operative day. This was the commonest complication reported, affecting over one in ten patients. Possible strategies to reduce length of stay in this situation could include peri-operative strategies such as increased use of staplers to close lung parenchyma, or implementing outpatient drain management pathways.

Fig. 7.22

Primary resections for lung cancer: Prolonged air leak; financial years 2014-2016 (n=2,352)



Reoperation

Reoperation is rare, accounting for just over one in every fifty lung cancer resections. We did not sub-classify by procedure performed, but it is likely that these operations included bronchoscopy procedures for sputum retention, re-exploration for bleeding, tracheostomy to facilitate artificial ventilation and treatment of other peri-operative complications for example laparotomy or gastrointestinal endoscopy. There may be variability across the country in how these interventions are performed which may affect results. For example, tracheostomy may be possible in the intensive care unit of some hospitals, but require a return to the operating theatre in others.

Fig. 7.23

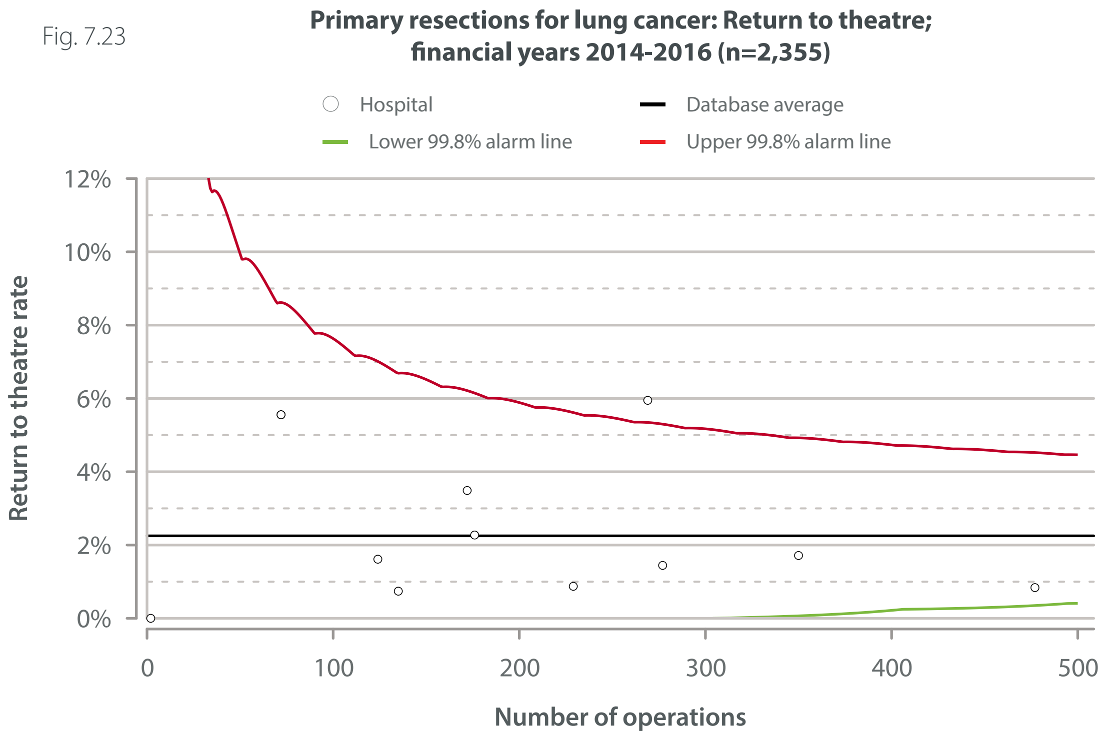


Fig. 7.24

Primary resections for lung cancer: Unplanned readmission to ICU; financial years 2014-2016 (n=2,369)

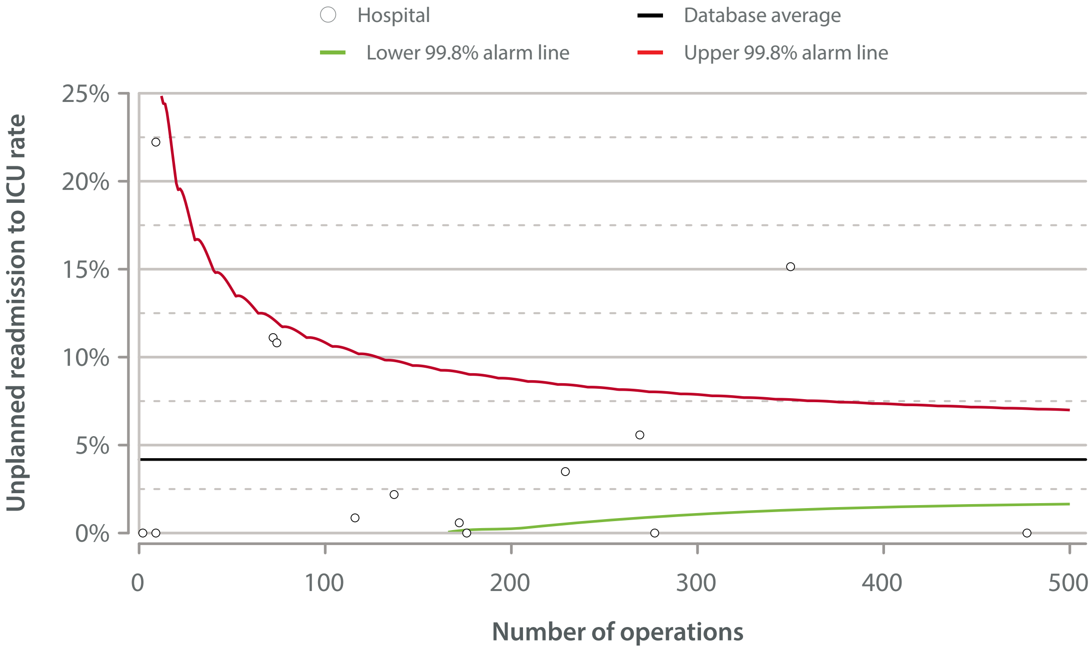
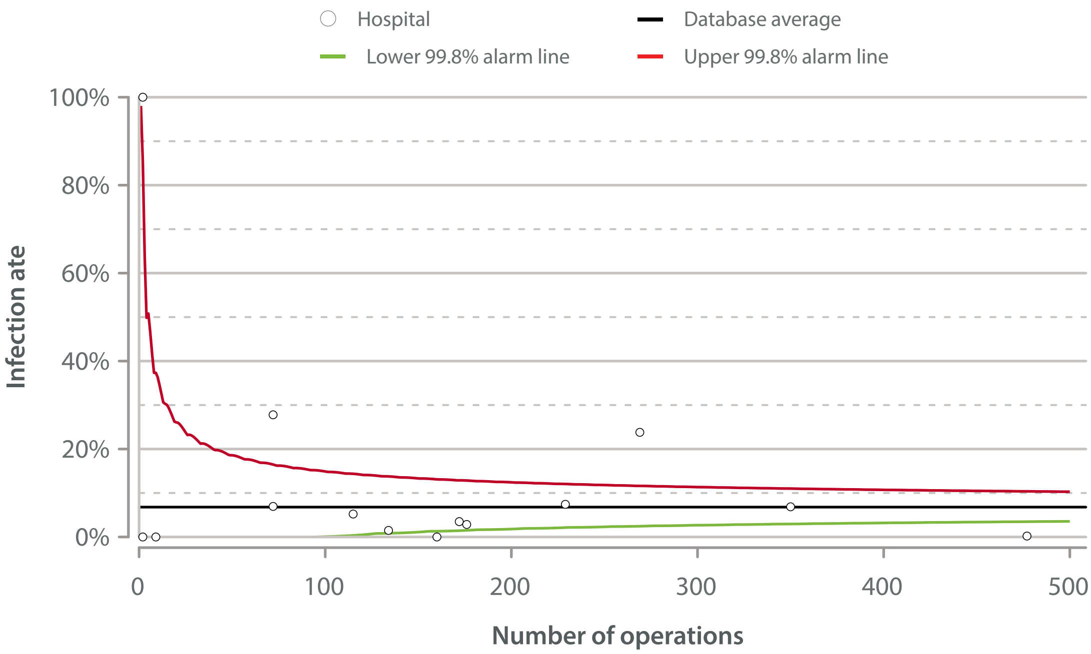


Fig. 7.25

Primary resections for lung cancer: Infection leading to prolonged hospital stay; financial years 2014-2016 (n=2,239)

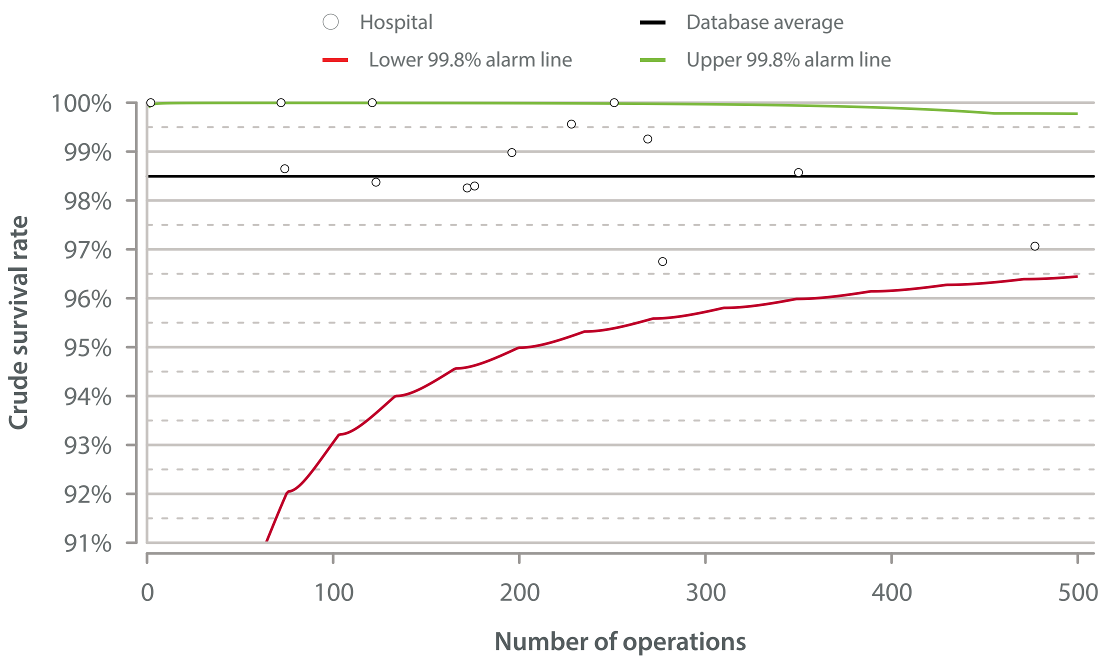


Survival

Unadjusted survival to hospital discharge by unit is shown in Fig. 7.26. The data shown are not adjusted for case mix. For an approximate comparison, the LCCOP project reported a 98.1% 30 day survival after lung cancer resection in England in the 2015 calendar year, around half way through the SCTS database project.

Fig. 7.26

Primary resections for lung cancer: In-hospital survival; financial years 2014-2016 (n=2,788)



References

1. Brunelli A, Charloux A, Bolliger CT, et al. ERS/ESTS clinical guidelines on fitness for radical therapy in lung cancer patients (surgery and chemo-radiotherapy). *European Respiratory Journal*. 2009; **34(3)**:782.
2. Sepesi B, Gold KA, Correa AM, et al. The Influence of Body Mass Index on Overall Survival Following Surgical Resection of Non-Small Cell Lung Cancer. *Journal of Thoracic Oncology*. 2017; **12(8)**: 1280-1287.
3. Baldwin DR, White B, Schmidt-Hansen M, Champion AR, Melder AM. Diagnosis and treatment of lung cancer: summary of updated NICE guidance. *British Medical Journal*. 2011; **342**: d2110.

Section 3

Pneumothorax and empyema surgery: a pilot study using Hospital Episode Statistics (HES) data

Chapter 8: Pneumothorax and empyema surgery

Introduction

Auditing thoracic surgery for benign disease

The Society welcomed the establishment of the LCCOP project in 2014, partnering with the National Lung Cancer Audit team to deliver the 2014 and all subsequent reports. However, this project only covers lung cancer resections, operations that consistently comprise less than a third of the total cases reported to the Thoracic Register. With the closure of the SCTS Database, the Society became concerned that the majority of thoracic surgical activity was not being included in any formal national audit.

In this section we report a novel pilot project, which the Society commissioned from the Clinical Evaluation Unit (CEU) at the Royal College of Surgeons of England. It aims to address the challenges of auditing non-lung cancer thoracic surgery, where multiple procedures are performed, mortality is thankfully uncommon and cancer registry data is not available. Ideally, clinical audit would be delivered at a reasonable cost, and without placing a heavy burden on clinicians to collect multiple data points for each patient.

In this project, we examine the feasibility of using routinely collected NHS activity data, known as the Hospital Episode Statistics, to evaluate the quality of clinical care at the level of surgical units.

The CEU has used the NHS England Hospital Episode Statistics (HES) database, and expertise in analysing this database to study the quality of surgical care in various projects. The Association of Upper Gastrointestinal Surgeons in Great Britain & Ireland (AUGIS) has used previously HES data to provide activity and outcome data for some general surgical procedures, in a project known as SWORD (http://www.augis.org/sword/).

The Society's commission to the CEU was to explore the utility of the HES dataset to audit outcomes in two significant areas of thoracic surgical practice not currently covered by the LCCOP programme, namely pneumothorax and empyema surgery. The study was limited to the English NHS, since this was the extent of coverage within the HES dataset.

The Hospital Episodes Statistics (HES) dataset and clinical audit

National clinical audits provide an important source of unit-level information for surgeons, NHS providers and patients on patterns of surgery and short-term outcomes. They are, though, reliant on hospitals submitting all cases to the audits to ensure that the audit results are not affected by differential reporting, which may in turn lead to unfair comparisons of outcomes across NHS trusts. The Hospital Episode Statistics (HES) database [1] provides an independent source of information on patterns of surgery within all English NHS hospitals. HES data also have a structure that enables information on longer-term outcomes such as 1-year reoperation rates to be derived, something that national clinical audits have difficulty in producing, due to the requirement for long-term follow-up.

Studies into the patterns of care within the English NHS that use data from HES have a number of strengths. First, HES should contain records on all inpatient admissions to thoracic or cardiothoracic units in England, and so a study should be able to analyse a complete population-based cohort. This reduces the risk of bias due to the study having an unrepresentative sample of cases. Second, HES allows the records of individual patients to be linked together, which enables studies to follow patients as they receive care at different points in time and at different NHS trusts. This is particularly valuable for studies of cardiothoracic surgery because patients may be transferred from hospitals without the facilities for this surgery to hospitals with cardiothoracic units. Nonetheless, various concerns have been raised about the quality of national administrative datasets, not least with regard to the accuracy of the coding of diagnoses and procedures, and it is not clear to what extent results produced from HES are robust and accurate.

Data used in the analysis

Overview of the HES database

This work was based on an extract of Hospital Episode Statistics (HES) that contained the records of adult patients with one of the selected cardiothoracic conditions, who were discharged from English HES hospitals between 1 April 2009 and 31 March 2014.

Each individual HES record corresponds to the time a patient is managed by the same consultant, either as a day case or during a hospital admission. Records contain information on the patient characteristics, their medical conditions, procedures, and admission details. Medical diagnoses are coded using the International Classification of Diseases (ICD, version 10) and procedures using the Office of Population, Census and Surveys (OPCS, version 4) codes.

In many cases, an episode of care will last the whole of a patient's inpatient stay within a hospital. However, there are patients who are managed by different consultants, and these patients will have multiple episodes of care during the same admission, and therefore multiple HES records. To distinguish admissions from episodes of care, the HES database labels a person's complete admission as a *spell*. Multiple records for the same patient will also arise if they are admitted or treated as a daycase on more than one occasion. The records related to an individual can be identified because they are allocated the same unique anonymised patient identifier (the HESID).

It is also possible that the entire period of continuous inpatient care was not within a single hospital. A person having a myocardial infarction may be transferred for surgery to another hospital in the same NHS trust or to a different NHS trust. It has become customary to describe these periods of continuous NHS inpatient care that covers transfers as a *super-spell*. The analysis of surgery received by patients with the selected cardiac and thoracic conditions was based on the creation of super-spells. The method used to create super-spells is described below.

Cleaning of HES records and super-spell definition

A concern that arises when using HES data relates to potential problems of poor quality data, such as the omission or miss-coding of information on diagnoses or procedures. A series of data cleaning steps were performed to ensure that the analysis based on those records which met a minimum standard of completeness. The cleaning process removed:

- any duplicate records (records that contained the same values in a core set of data items)
- any records that did not have an admission date, or that did not have a unique discharge date (some records had either no date or more than one coded)
- any records with an invalid spell identifier (susspellid)

One of the reasons for these cleaning steps was to ensure that the algorithm that created the super-spells functioned correctly. This was based on linking a series of spells relating to an individual patient, in which the discharge date of one spell matched the admission date of another spell. The algorithm did not explicitly make use of the HES fields that described the discharge destination or the source of admission. While these often contained values that were consistent with a patient being transferred, there were inconsistencies within these data items that made their inclusion into the super-spell algorithm problematic.

Data cleaning and statistical analysis was carried out using STATA version 14.1.

Pneumothorax surgery

Executive summary

- 61,666 patients were admitted to English NHS hospital over five years with a diagnosis of pneumothorax.
- slightly more than one-third did not undergo any procedure during their admission, while nearly a half had a non-surgical intervention, most commonly drain insertion.
- less than one-sixth of pneumothorax admissions underwent surgery of some kind. About a third of these had another procedure (usually chest drain placement) on the same admission before surgery.
- categorising patients by diagnosis suggests that one-third had *primary* pneumothorax, without respiratory comorbidity.
- smoking was more common in primary (39%) and secondary (52%) pneumothorax patients than in the general population.
- less than 0.5% of primary pneumothorax patients died within 30 days of surgery, rising to over 2% in secondary pneumothorax.
- in both primary and secondary pneumothorax, around one in ten patients were readmitted within 30 days of surgery.
- more than one in ten patients were readmitted with a diagnosis of pneumothorax within a year of surgery, and 8.7% underwent a further procedure.
- in the subset for whom laterality was recorded, the estimated one-year risk of ipsilateral reintervention was 3.4%.
- coding of surgical procedures did not map directly to widely used descriptions of surgery such as surgical pleural abrasion, pleurectomy or chemical pleuro desis.

Objectives and methods

This section examines the management of patients who were admitted with pneumothorax, with a particular focus on the surgical procedures that they underwent. The analysis covers both primary and secondary pneumothorax, and describes the care pathway during a single continuous period of inpatient stay during which patients may have undergone one or more therapeutic interventions [4]. The specific objectives were to describe, at a national level and by NHS trust:

- the patterns of treatment among adult patients with pneumothorax admitted to NHS hospitals in England between 1 April 2009 and 31 March 2014.
- the short-term outcomes of surgery in terms of post-operative length-of-stay (LOS), 30-day (in-hospital) post-operative mortality or 30-day re-admission rate.
- rates of 1-year readmission with a diagnosis of pneumothorax.

The analysis was based on a cohort of adult patients (16 years or over) who were resident in the UK and who were admitted with a diagnosis of pneumothorax (ICD-10 code: J93) between 1 April 2009 and 31 March 2014 (five years). Patients were included in the initial extract if the ICD-10 code J93 appeared in any of the diagnostic fields. Patients were then allocated to one of five categories of pneumothorax based on the presence of other ICD-10 conditions alongside the pneumothorax diagnosis. The five groups were labelled and defined as follows:

- primary (or spontaneous) pneumothorax (PP). These patients only had an underlying diagnosis of pneumothorax, with no other diagnosis code indicative of underlying lung disease, and contributed 36.9% of the patient records with pneumothorax.
- secondary pneumothorax (SP), with the subgroups of:
    1. Respiratory related SP (J93 + pneumonia, asthma, emphysema, bronchitis, other respiratory conditions), found to be 51.7% of the records with pneumothorax.
    2. Cancer related SP (J93 + {C34 or C4x or C5x or C7x}), found to be 7.4% of the records with pneumothorax.
    3. Traumatic SP (J93 + ICD-10: S-codes), found to be 2.2% of the records with pneumothorax.
    4. Iatrogenic SP (J93 + ICD-10: T818)), found to be 1.8% of the records with pneumothorax.

We found that some of the pneumothorax records were associated with admissions in which cardiac surgery was performed (these typically had a principal diagnosis related to ischaemic heart diseases). These records were removed from the analysis.

A minority of records met the criteria for several of the secondary pneumothorax groups, and so patients were allocated in a hierarchical manner. Specifically, patients were allocated to the secondary pneumothorax group with the lowest numeric label (*e.g.,* if there was a mention of respiratory illness and cancer, the record was allocated to the respiratory group; if there was a mention of cancer and iatrogenic, the patient was allocated to the cancer group). In later analyses, the traumatic and iatrogenic pneumothorax groups were ignored because they formed a small percentage of the total.

Patients admitted with pneumothorax can be managed in a variety of ways [4]. They could be managed medically (and have no therapeutic intervention recorded in the procedure fields). Other patients might have aspiration, a chest tube insertion, pleurodesis or a pleural excision procedure. The specific OPCS codes used to identify these different interventions are described in Table 8.01. Patients were included in the analysis if they had a procedure code in any of the procedure fields together with pneumothorax in a diagnosis field. A full list of the OPCS codes and ICD-10 codes can be found in Appendix 5.

Table 8.01 Definition of five types of intervention that patients with pneumothorax underwent

		Procedure codes (OPCS)
Type of procedure	Excision	T07.8, T07.9, A12.3
	Surgical pleurodesis	T09.3, T09.4, T09.5, T10.2, T10.3, T10.9
	Medical pleurodesis	T13.1, 13.9
	Aspiration	T12.3
	Tube insertion	T12.1, T12.2, T12.4

The primary outcomes were: post-operative length-of-stay, 30-day in-hospital post-operative mortality, 30 day readmission rates and rates of 1-year readmission with a diagnosis of pneumothorax. Figures for these outcome measures were derived for the whole patient cohort and for each NHS thoracic unit. Unit-level post-operative mortality and both readmission rates were risk adjusted using information available within HES. The models included: patient age, sex, type of pneumothorax, mode of admission (emergency, elective, transfer), and the number of selected comorbidities. Comorbidities were measured using the RCS Charlson score [2].

Overall patterns of surgery for pneumothorax and outcomes

During the five-year period, there were a total of 61,666 patients admitted to an English NHS hospital with a diagnosis of pneumothorax. The care pathways that these patients followed during a continuous period of inpatient stay are summarised in Table 8.02. For about one-third of patients (n=23,388), the care pathway did not involve any intervention. For others, their management could involve one or more procedures. For those patients having multiple interventions, the sequence of procedures often occurred on different days. Nonetheless, in some records, two procedures were found on the same day; in these instances, the patient was listed as having the most invasive.

Table 8.02 reveals that, as expected, non-surgical treatments such as aspiration and tube insertion were sufficient for most patients. However, there were 8,930 patients who underwent a surgical intervention, of which 4,898 were surgical pleurodesis and 4,032 were open excision. A sizeable proportion of these were undertaken after the patient had already had another intervention (typically, tube insertion). Among the open excision procedures, the majority were performed using a VATS approach (n=3,328; 82.5%).

Table 8.02 Levels of surgical activity by type of procedure as pathways of treatment for pneumothorax between 1 April 2009 and 31 March 2014

		Primary intervention	After aspiration	After tube insertion	Total
Procedure	None	23,388	0	0	**23,388**
	Aspiration only	3,239	0	0	**3,239**
	Tube insertion only	24,429	721	0	**25,150**
	Medical pleurodesis	244	8	707	**959**
	Excision [i]	2,725	42	1,265	**4,032**
	Surgical pleurodesis	2,712	33	2,153	**4,898**
	All patients				**61,666**

i. May be coded with plueurodesis

The characteristics of the patients having surgery are described in Table 8.03. Patients were predominantly male, with an age distributions varying by the type of pneumothorax. The median age was 29 years (IQR: 22 to 44) for primary (spontaneous) pneumothorax; 42 years (IQR: 26 to 64) for secondary pneumothorax related to respiratory disease, and 70 years (IQR: 60 to 78) for cancer related pneumothorax. Smoking was relatively common across all groups.

Comorbidities were most prevalent among patients with pneumothorax related to cancer, which is to be expected given the distribution of ages across the groups. Diabetes was the most common comorbidity within each of the pneumothorax types. Patients with cancer SP were also more frequently coded as suffering from pleural effusion as well as pneumothorax.

Table 8.03 Characteristics of patients having pneumothorax surgery between April 2009 and March 2014

Characteristics	Primary pneumothorax	Secondary pneumothorax	Cancer pneumothorax
Count of patients	2,764	5,618	548
Proportion of men	73%	74%	56%
Proportion of women	27%	26%	44%
Median age / years	29	42	70
Inter-quartile range / years	22-44	26-64	60-78
Smoking history	39%	52%	30%
Pleural effusion	7%	7%	39%
Elective admission	53%	37%	41%
Emergency admission	26%	34%	48%
Transfer: originally elective	4%	4%	1%
Transfer: originally emergency	16%	24%	9%
Myocardial infarction	0.8%	1.4%	2.9%
Congestive cardiac failure	1.4%	2.3%	3.8%
Peripheral vascular disease	1.9%	3.2%	3.3%
Cerebral vascular disease	0.5%	0.9%	1.5%
Diabetes	2.3%	4.1%	9.5%
Renal disease	1.3%	1.7%	3.8%

A summary of the overall outcomes by type of procedure is given in Table 8.04. Patients with primary pneumothorax had the shortest LOS in general (typically 3 to 6 days). Rates of 30-day in-hospital mortality were very low for open excision procedures, with most 30-day in-hospital deaths occurring among patients undergoing surgical pleurodesis. Post-operative mortality was less than 1% for patients with primary pneumothorax, but increased to 3.9% for respiratory secondary pneumothorax, and 5.8% for those with an underlying cancer diagnosis.

The 30-day readmission rates increased across each pneumothorax group in a similar manner, typically occurring among 1 in 10 patients with both primary and respiratory secondary pneumothorax, and around 1 in 4 patients with cancer related secondary pneumothorax.

We calculated 1-year readmission rates, using those patients for which the dataset contained a least one year of follow-up. A patient was flagged as having a 1-year readmission if they were admitted to any English NHS hospital with a diagnosis of pneumothorax within a year of the first surgical procedure for pneumothorax in the dataset. The overall rate of 1-year readmission was 13.1%, and there was very little variation across the three types of disease (Table 8.04). It is difficult to tell if these readmissions involved a pneumothorax on the same side as the original because laterality is only recorded in the OPCS procedure codes. Consequently, laterality was only available among patients who had an intervention (either aspiration, tubal insertion, pleurodesis, excision).

Table 8.04 Outcomes by type of procedure for patients having pneumothorax surgery between April 2009 and March 2014 in all hospitals

Outcomes	Primary pneumothorax	SP	Cancer SP
Total	**2,764**	**5,618**	**548**
Median LOS / days	4	5	5
LOS inter-quartile range / days	3-6	3-8	3-9
Surgical pleurodesis			
Count	1,245	3,138	514
30-day in hospital deaths	7	122	30
Mortality rate	0.6%	3.9%	5.8%
Open excision			
Count	1,517	2,479	34
30-day in hospital deaths	<5	10	0
Mortality rate	0.1%	0.4%	0.0%
Overall 30-day readmission rate	9.1%	11.4%	23.6%
Overall 1-year readmission rate for pneumothorax [ii]	12.4%	13.5%	13.0%

Outcomes of surgery for pneumothorax by NHS unit

The outcomes of pneumothorax related surgical procedures were described for each thoracic unit in relation to four measures: post-operative length of stay, 30-day in-hospital post-operative mortality for surgical pleurodesis, 30-day readmission, and 1-year readmission for pneumothorax. The unit-level figures are summarised in Appendix 6.

The comparative risk-adjusted post-operative mortality rates for individual NHS thoracic units are shown in the funnel plot in Fig. 8.01. The 99.8% control limit defines the region within which the mortality rates would be expected to fall if the organisations' outcomes only differed from the national rate because of random variation. The national rate for the thoracic units was lower than the overall average. Of the 4,897 surgical pleurodesis procedures performed during the study period, 4,100 (84%) were performed within NHS trusts with thoracic units and 797 (16%) were performed in other NHS trusts. The overall mortality rates of the NHS trusts with and without a thoracic unit were 2.02% and 9.54%, respectively. The data suggested that NHS trusts without thoracic units tended to treat patients with greater disease burden, but the difference in mortality between NHS trusts with / without thoracic units was only partially explained by these differences in patient casemix. The adjusted odds ratio for 30-day inpatient mortality for thoracic units, compared to other NHS trusts, was 0.57 (95% CI: 0.39 to 0.83).

It is not clear what these procedures performed outside thoracic units represent. Possibilities include bedside pleurodesis procedures performed in medical or oncology wards and often on patients considered unfit for surgery, miscoding, surgery performed *off-site* by visiting thoracic surgeons, or possibly surgery by non-thoracic surgeons. As far as we are this last possibility is highly unusual in clinical practice.

ii. Calculated on patients having pneumothorax surgery between April 2009 and March 2013

Fig. 8.01 **Pneumothorax surgical pleurodesis : Risk-adjusted 30-day in-hospital post-operative mortality for English NHS thoracic units; financial years 2010-2014**

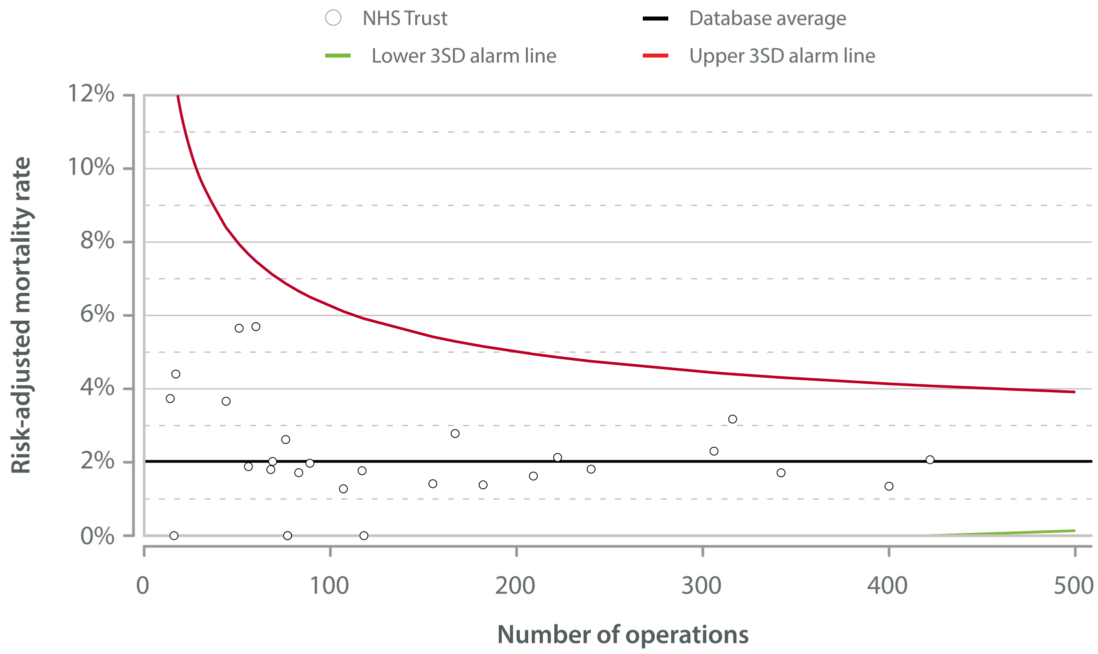


Fig. 8.02 shows the comparative, risk-adjusted 30-day readmission rates among patients having surgery for pneumothorax at individual NHS thoracic units. The funnel plot shows the risk adjusted rates for most thoracic units fell between 5% and 15%, and all but one were within the expected distance of the overall national average rate of 10.3%. One unit had a rate that fell below the lower control limit.

Fig. 8.02 **Pneumothorax excision / surgical pleurodesis : Risk-adjusted 30-day readmission for English NHS thoracic units; financial years 2010-2014**

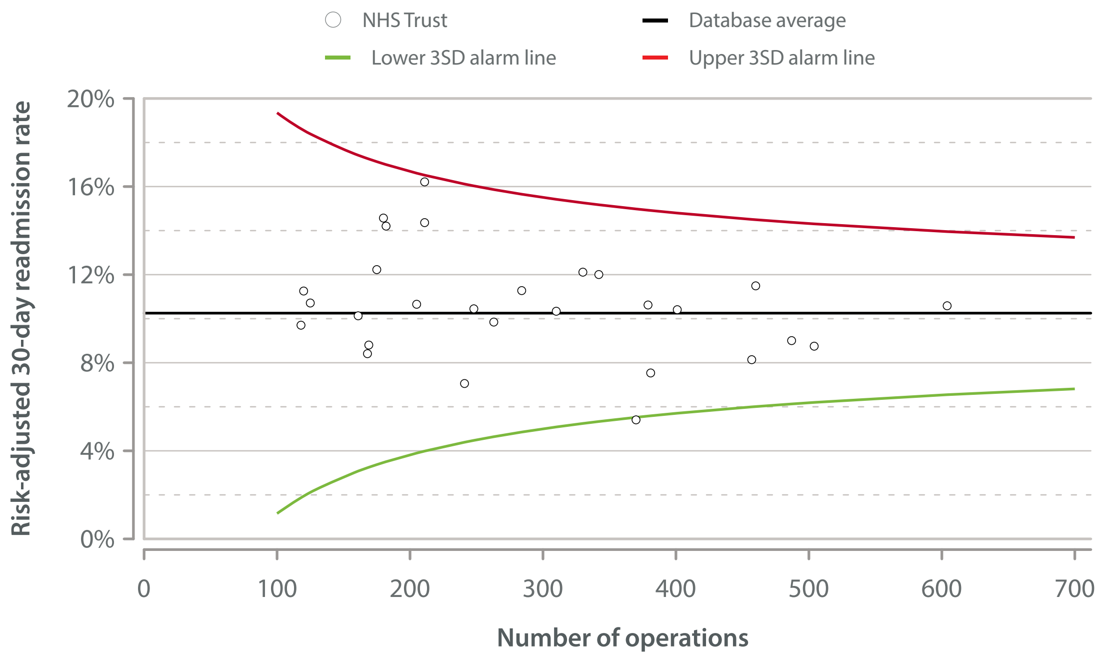
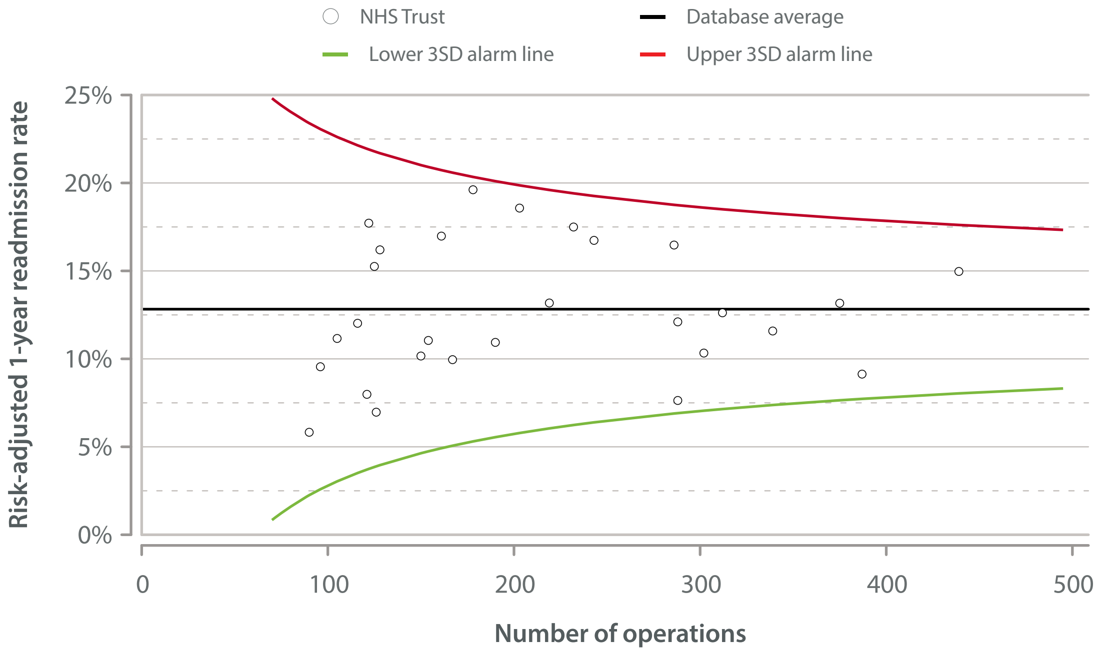


Fig. 8.03 shows the risk-adjusted 1-year readmission rates among patients having surgery for pneumothorax at individual NHS thoracic units. The 1-year readmission rate was calculated for all admissions that involved a diagnosis of pneumothorax, the overall average of which was 12.8% for the NHS trusts with thoracic units. The funnel plot shows the risk adjusted rates for most thoracic units fell between 5% and 20%, and all were within the expected range.

Fig. 8.03 **Pneumothorax excision / surgical pleurodesis : Risk-adjusted 1-year readmission for English NHS thoracic units; financial years 2010-2014**



Thoracic surgery for pleural sepsis

Executive summary

- 40% of empyema admissions do not involve any operation or procedure. A further 39% have either a pleural aspiration or chest drain, but no surgical procedure.
- in the five-year study period, 3,367 patients were recorded as undergoing surgery.
- around one-quarter of patients having empyema surgery have a drain placed earlier on the same admission.
- a third of surgery was performed using a VATS approach.
- length-of-stay was longer than for pneumothorax surgery.
- mortality rose from 0.3% in patients without comorbidity undergoing surgical resection, to 1.1% in patients with respiratory comorbidity, and 5.3% in those with a cancer diagnosis.
- mortality was higher for surgical drainage procedures than for excision in every group studied; 1.2% without comorbidity and 4.8% in patients with respiratory comorbidity. This difference persisted after adjustment for comorbidity (adjusted OR 0.35; 95% CI 0.22 to 0.57).
- there was some evidence for miscoding, with 3% of surgical procedures recorded in Trusts with no thoracic surgical units.

Study objectives and methods

This section examines the management of patients who were admitted with pleural sepsis / empyema. As before, we describe the care pathway during a single continuous period of inpatient stay, during which patients may have undergone one or more therapeutic interventions, although the focus is on the surgical procedures that they underwent.

The specific objectives were to describe, at a national level and by NHS trust:

- the patterns of management among adults with empyema admitted to NHS thoracic or cardiothoracic units in England over the five-year period between 1 April 2009 and 31 March 2014.
- the outcomes of surgery in terms of post-operative length-of-stay (LOS), 30-day (in-hospital) post-operative mortality or 30-day re-admission rate.

The analysis was based on a cohort of adult patients (16 years or over) who were resident in the United Kingdom and were admitted with a diagnosis of empyema (ICD-10 code: J86) between 1 April 2009 and 31 March 2014. Patients were included in the initial extract if the ICD-10 code J86 appeared in any of the diagnostic fields. Patients were then allocated to one of four categories based on the presence of other ICD-10 conditions alongside the empyema diagnosis. The four groups were labelled and defined as follows:

- primary empyema (PE). The records of these patients had only the empyema diagnosis, and were found to be 31.2% of the total cases of empyema;
- secondary empyema (SE), with the subgroups of:
    1. Respiratory disease related SE (J86 + pneumonia, asthma, emphysema, bronchitis, other respiratory conditions), found to be 49.1% of the total empyema cases.
    2. Cancer related SE (J86 + {ICD-10 codes: C34 or C15 / C16 or C45 or C5x or C7x}), found to be 7.5% of empyema cases.
    3. Traumatic SE (J86+ {ICD-10: *S-codes*}) and / or Iatrogenic SE (J86 + {ICD-10: T814, T818}), which accounted for 12.2% of empyema cases.

A minority of records met the criteria for inclusion in several of the secondary empyema groups, and so patients were allocated in a hierarchical manner. Specifically, if a patient record included diagnosis codes indicative of traumatic or iatrogenic SE, the patient was allocated to this group. Otherwise, if a patient record included diagnosis codes indicative of cancer, the patient was allocated to the cancer group.

Patients admitted with empyema can be managed in a variety of ways [5]. They could be managed medically (and have no therapeutic intervention recorded in the procedure fields). Other patients might have aspiration, a tube inserted, pleurodesis or an excision. The specific OPCS codes used to identify these different interventions are described in Table 8.05. Patients were included in the analysis if they had a procedure code in any of the procedure fields together with empyema in a diagnosis field. A full list of the OPCS codes and ICD-10 codes can be found in Appendix 5.

Table 8.05 Definition of surgical interventions for patients admitted with empyema

		Procedure codes (OPCS)
Type of procedure	Excision	T01.1,T01.3, T07.1
	Surgical drain	T08.1, T08.3, T08.8, T08.9
	Other surgery	T09.8, T09.9, T10.8
	Aspiration	T12.3
	Tube insertion	T12.1, T12.2, T12.4

The primary outcomes were: post-operative length-of-stay, 30-day in-hospital post-operative mortality, and 30-day readmission rates. Figures for these outcome measures were derived for the whole patient cohort and for each NHS thoracic unit. Unit-level post-operative mortality and 30-day readmission rates were risk adjusted using information available within HES. The models included: patient age, sex, type of empyema, type of surgery, and the number of comorbidities. As before, comorbidities were measured using the RCS Charlson score [2].

Overall patterns of surgery for pleural sepsis and outcomes

There were a total of 23,634 patients admitted to an English NHS hospital with a diagnosis of empyema over the five-year period between April 2009 and March 2014. The care pathways that these patients followed during a continuous period of inpatient stay are summarised in Table 8.06. For about 40% of patients (n=9,573), the pathway did not involve any intervention. For others, their management could involve one or more procedures. Table 8.06 summarises the major management pathways, describing the sequence of interventions that occurred on different days. If two procedures were performed on the same day, the patient was listed in Table 8.06 as having the most invasive.

Table 8.06 reveals that, of the various interventions, tube insertion was sufficient for most patients. Among the 3,367 patients who underwent a surgical intervention, the majority had an open excision. About one-quarter of these were undertaken after the patient had already had another intervention (typically, tube insertion). Compared with patients having surgery for pneumothorax, the use of VATS for open excision was less common; 775 of the excision operations were performed using VATS (34.6%).

The majority of the surgical activity identified within HES was performed in NHS trusts with a thoracic unit, with 97% of both surgical drains and open excision being identified at these providers. The following analysis limits the results to patients having surgery in thoracic units.

Table 8.06 Care pathways for patients with empyema admitted to English NHS trusts between April 2009 and March 2014

		Primary intervention	After aspiration	After tube insertion	Total
Care pathway	None	9,573	0	0	**9,573**
	Aspiration only	1,379	0	0	**1,379**
	Tube insertion only	8,462	853	0	**9,315**
	Excision	1,558	85	594	**2,237**
	Surgical drain	666	28	229	**923**
	Other surgery	149	7	51	**207**
	All patients				**23,634**

The characteristics of the patients having surgery are described in Table 8.07. Most were admitted after an emergency admission, either at the thoracic unit or at the initial hospital before the patient was transferred. The patients were predominantly male, with a median age around 55 years (IQR: 40 to 74) for most empyema patients (those with an underlying cancer diagnosis were slightly older). Smoking was relatively common across all groups. The relative frequency of comorbidities was similar across the various groups of empyema, with diabetes being the most prevalent across all three groups.

Table 8.07 Characteristics of patients having empyema surgery in English thoracic units between April 2009 and March 2014

		Primary empyema	SE c̄ respiratory disease	SE c̄ cancer	SE c̄ traumatic or iatrogenic
Characteristics	Count of patients	960	1,510	230	374
	Proportion of men	77%	67%	78%	77%
	Proportion of women	23%	33%	22%	23%
	Median age / years	56	54	66	57.5
	Age inter-quartile range / years	41-66	40-66	58-74	43-68
	Smoking history	34%	39%	37%	29%
	Pleural effusion	17%	31%	20%	22%
	Elective admission	41%	19%	40%	25%
	Emergency admission	30%	42%	37%	38%
	Transfer: originally elective	8%	6%	4%	7%
	Transfer: originally emergency	21%	33%	19%	29%
	Myocardial infarction	3%	2%	4%	2%
	Congestive cardiac failure	5%	6%	6%	6%
	Peripheral vascular disease	3%	4%	7%	4%
	Cerebral vascular disease	1%	2%	2%	4%
	Diabetes	13%	13%	13%	10%
	Renal disease	5%	6%	7%	4%

SE = Secondary empyema

Table 8.08 summarises the overall outcomes for patients with empyema. Typically lengths of stay could extend from around a week to two weeks, with a sizeable proportion of patients with traumatic / iatrogenic SE staying over 3 weeks. The risk of post-operative mortality increased across the various types of empyema, being the highest amongst patients with cancer SE or traumatic / iatrogenic SE. The risk of death was also greater among patients having a surgical drain compared with patients having open excision.

Table 8.08 Outcomes by type of procedure for patients having empyema surgery in English thoracic units between April 2009 and March 2014

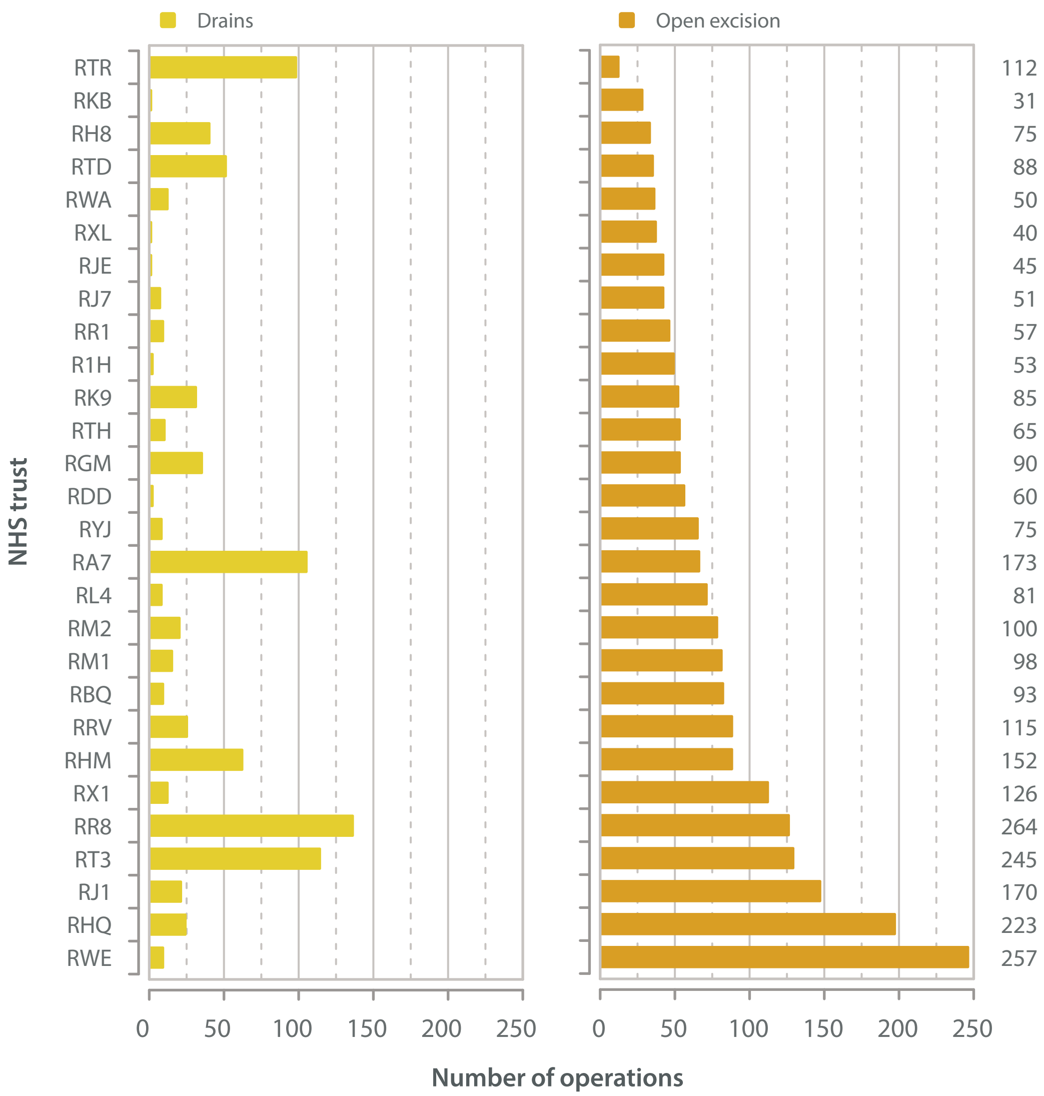
		Primary empyema	SE c̄ respiratory disease	SE c̄ cancer	SE c̄ traumatic or iatrogenic
Outcomes	**Total**	**960**	**1,510**	**230**	**374**
	Median LOS / days	6	8	9	13
	LOS inter-quartile range	4-9	5-15	5-17	6-26
	Surgical drain				
	Count	251	414	116	115
	30-day in hospital deaths	<5	20	11	13
	Mortality rate	1.2%	4.8%	9.5%	11.3%
	Open excision				
	Count	708	1,096	114	259
	30-day in hospital deaths	<5	12	6	11
	Mortality rate	0.3%	1.1%	5.3%	4.2%

Outcomes of surgery for pleural sepsis by NHS unit

The outcomes of the surgical procedures for empyema were described for each thoracic unit in relation to three measures: length-of-stay, 30-day in-hospital post-operative mortality and 30-day readmission. The unit-level figures are summarised in Appendix 6.

In Table 8.08, there was a noticeable difference in the mortality risk between the open excision and surgical drain procedures. This is possibly due to differences in the characteristics of patients selected for either operation. However, we note that, when adjusted for patient age, type of empyema and the presence of comorbidities, there was still a lower risk associated with open excision (adjusted OR = 0.35; 95% CI 0.22 to 0.57). We also note that there was considerable variation in the pattern of procedures across the units (Fig. 8.04).

Fig. 8.04 **Empyema: Patterns of surgical activity across English NHS hospitals; financial years 2010-2014**



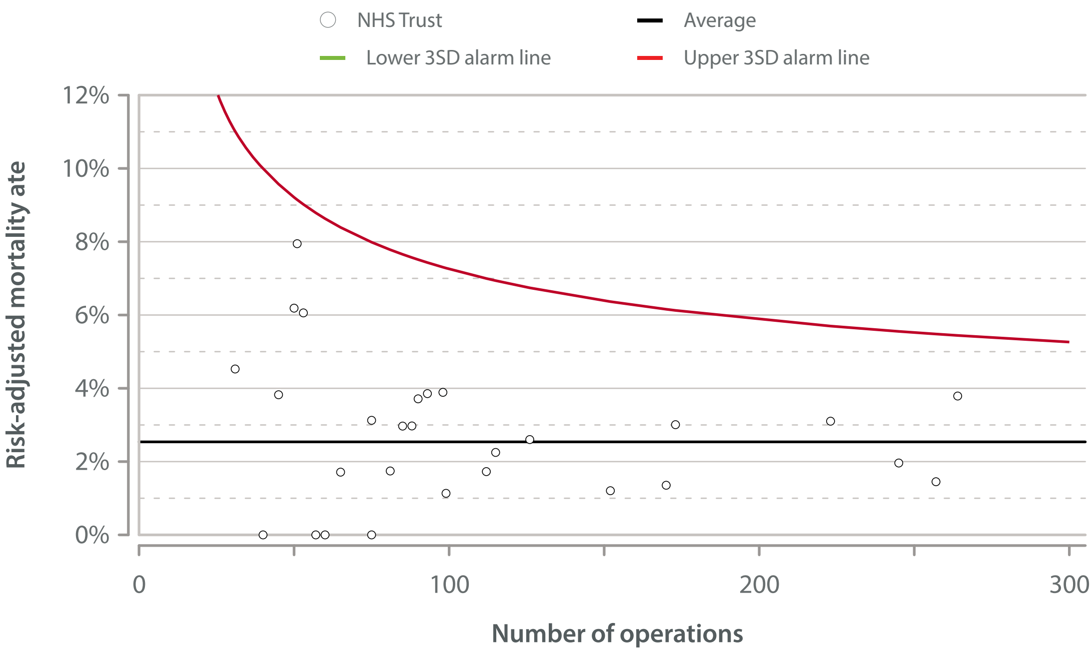
The comparative, risk-adjusted post-operative mortality rates for individual NHS thoracic units are shown in Fig. 8.05. The 99.8% control limit defines the region within which the mortality rates would be expected to fall if the organisations' outcomes only differed from the national rate because of random variation. The pooling of the five years of unit activity gives levels of volume that range from around 50 to 250 procedures. The 99.8% control limits are comparatively wide.

The funnel plot shows the risk-adjusted rates for most thoracic units typically range from between 0% and 4%.

Most values fall within the expected distance of the overall national average rate of 2.54% (*i.e.,* they were within the 99.8% control limits). There are no units that fall outside the upper limit for this five-year period.

Fig. 8.05

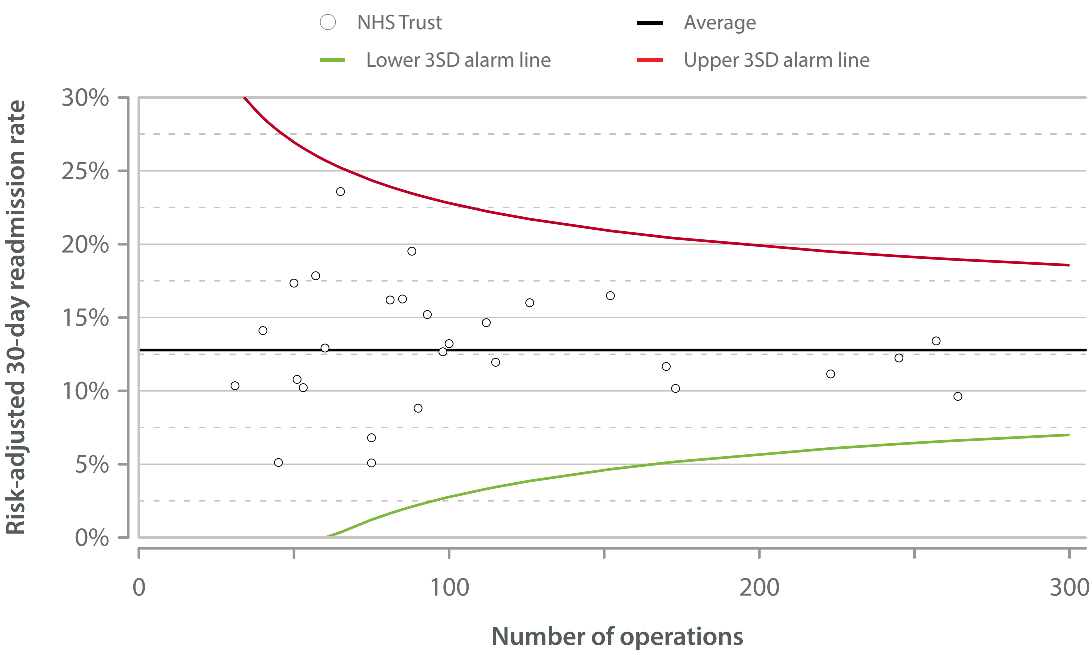
Empyema : Risk-adjusted 30-day in-hospital post-operative mortality for English NHS thoracic units; financial years 2010-2014



The comparative, risk-adjusted 30-day readmission rates for individual NHS units are shown in Fig. 8.06. The funnel plot shows the risk-adjusted rates for most thoracic units fell between 5% and 24%. As before, all values are within the expected distance of the overall national average rate of 12.8%. There are no units that fall outside the upper or lower limits for this five-year period.

Fig. 8.06

Empyema : Risk-adjusted 30-day readmission for English NHS thoracic units; financial years 2010-2014



Conclusion

The aim of the work described in this chapter was to explore the ability of Hospital Episode Statistics (HES) data to describe patterns of thoracic surgery for patients with pneumothorax and pleural sepsis across English NHS trusts. Overall, the information entered into HES records about these procedures is sufficient to derive useful information about surgical activity and outcomes, for both England and by individual hospital trusts. A definitive assessment of its accuracy was beyond the scope of this project and requires comparison of these results with findings from other sources. We would recommend that this comparison is undertaken where possible.

Using HES-based results to describe the activity of thoracic units and their surgical outcomes appears feasible. Information which complements the SCTS returns can be produced using HES, without requiring extra data input from clinicians. For example, in this analysis, it was possible to derive an additional outcome measure, 30-day readmission rates, which the SCTS currently does not produce.

There is clearly the potential to derive other measures of surgical outcome. This was illustrated in the work on outcomes after surgery for pneumothorax. The ability to link the HES records of patients admitted multiple times meant that it was possible to derive rates of 1-year readmission for pneumothorax among patients who had undergone an initial procedure for this condition. The absence of ICD-10 codes for laterality, and the omission of some OPCS laterality codes when a patient underwent an intervention prevented the analysis from clearly establishing whether the readmission-related pneumothorax was on the same side as the original problem, but as far as we are aware, these are the most robust results currently available.

Another benefit of analysing HES data is the ability to construct a picture of the care pathway prior to surgery. In this work, this ability extended to providing insights into both the reasons for admission prior to transfer to a thoracic unit from another hospital, and the interventions that a patient underwent prior to thoracic surgery.

In summary, this work demonstrates the potential of using HES data to describe patterns of care delivered within English NHS thoracic units, and to derive information on the outcomes of surgery. A benefit of this approach is its coverage of admissions within NHS hospitals and the relatively low cost of accessing the data.

There are clearly limitations within the HES database, not least in terms of the lack of information on important clinical aspects of a patient's condition and in terms of possible data errors. The possibility of bias due to data errors means that any analysis needs to be carefully planned and involve a clear data preparation stage. If these steps are implemented, it should be possible to produce unit-level information from HES that is useful to surgeons, surgical units and patients.

References

1. NHS Digital. Hospital Episode Statistics: HES User Guide, 2010. http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=459.
2. Armitage JN, van der Meulen JH, Royal College of Surgeons Co-morbidity Consensus G. Identifying co-morbidity in surgical patients using administrative data with the Royal College of Surgeons Charlson Score. *British Journal of Surgery*. 2010; **97(5)**: 772-78.
3. Spiegelhalter DJ. Funnel plots for comparing institutional performance. *Statistics in Medicine*. 2005; **24(8)**: 1185-202.
4. MacDuff A, Arnold A, Harvey J; BTS Pleural Disease Guideline Group. Management of spontaneous pneumothorax: British Thoracic Society Pleural Disease Guideline 2010. *Thorax*. 2010; **65(2)**: ii18-31. doi: 10.1136/thx.2010.136986.
5. Davies HE, Davies RJ, Davies CW; BTS Pleural Disease Guideline Group. Management of pleural infection in adults: British Thoracic Society Pleural Disease Guideline 2010. *Thorax*. 2010; **65(2)**: ii41-53. doi: 10.1136/thx.2010.137000.


Contents

Appendices

Appendices

1. Society for Cardiothoracic Surgery unit audit leads in 2015-2016

Lead	Hospital or Trust
Mr Doug **Aitchison**	Basildon and Thurock University Hospitals
Mr Tim **Batchelor**	Bristol Royal Infirmary
Ms Elizabeth **Belcher**	John Radcliffe Hospital
Mr Ehab **Bishay**	Heart of England NHS Trust
Mr Alex **Brunelli**	Leeds Teaching Hospitals
Mr Andy **Chukwuemeka**	Imperial College Healthcare
Mr Aman **Coonar**	Papworth Hospital
Mr John **Duffy**	Nottingham City Hospital
Mr Andy **Duncan**	Blackpool Teaching Hospitals
Mr Joel **Dunning**	James Cook University Hospital
Mr Jonathan **Edwards**	Northern General Hospital
Mr Hussein El **Shafei**	Aberdeen Royal Infirmary
Mr Peter **Froeschle**	Royal Devon & Exeter NHS Trust
Mr Shilly **Ghosh**	North Staffordshire Royal Infirmary
Mr Ira **Goldsmith**	Morriston Hospital
Mr Martin **Hayward**	University College Hospital London
Mr David **Healy**	Mater Misericordae University Hospital
Mr David **Healy**	St Vincent's University Hospital
Mr John **Hinchion**	Cork University Hospital
Mr Mark **Jones**	Royal Victoria Hospital
Mr Alan **Kirk**	Golden Jubilee National Hospital
Ms Margaret **Kornaszewska**	University Hospital of Wales
Mr Kelvin **Lau**	St Bartholomews Hospital
Mr Eric **Lim**	Royal Brompton and Harefield Hospitals
Mr Mahmoud **Loubani**	Castle Hill Hospital
Mr Adrian **Marchbank**	Derriford Hospital
Mr Joe **Marzouk**	University Hospitals, Coventry & Warwickshire NHS Trust
Mr Kandadai **Rammohan**	South Manchester University Hospital
Mr Sri **Rathinam**	Glenfield Hospital
Mr Ronan **Ryan**	St James's Hospital
Mr Sasha **Stamenkovic**	Freeman Hospital
Ms Carol **Tan**	St George's Hospital
Mr Marc VanLeuvan	Norfolk and Norwich University Hospital
Mr Dave **Verasingham**	University Hospital Galway
Mr Lukacs **Veres**	Guy's and St Thomas' Hospital
Mr Bill **Walker**	Royal Infirmary of Edinburgh
Mr Edwin **Woo**	Southampton General Hospital
Mr Steve **Wooley**	Liverpool Heart and Chest Hospital
Mr Patrick **Yiu**	Royal Woverhampton Hospitals NHS Trust

2. Guidance notes & definitions for submission of data to the SCTS Thoracic Returns

2015-2016

1. **Audit period**

   The audit period is cases operated during the 2015-2016 financial year *i.e.,* 1st April 2015 - 31st March 2016.

   Patients operated on in one audit year but dying in the next audit year should be recorded in the year during which the surgical procedure took place.

2. **Case inclusion**

   All cases of the named procedure performed in your department should be included. This should all cases regardless of their funding status (*i.e.,* all NHS, insured and self-funded cases).

3. **Outcome measure**

   The only outcome measure is in-hospital mortality. That is, death occurring during the same hospital admission as the surgical procedure being recorded. Deaths after discharge, or transfer to another hospital or care facility are not recorded.

4. **Multiple procedures mortality reporting**

   In the case of a patient undergoing multiple procedures before an in-hospital death, the mortality should normally be linked to the first procedure performed during the admission in which mortality occurred.

   For example, a lung cancer patient undergoes staging mediastinoscopy. They are subsequently readmitted for lobectomy. Post-operatively they undergo decortication for sepsis before in-hospital death. Their death is linked to their lobectomy- the first procedure performed on their final admission, but not to their mediastinoscopy or decortication.

5. **Private hospitals and *off-site* operating**

   NHS organisations commonly commission thoracic surgery that takes place on other sites, for example local private hospitals. Similarly, individual surgeons will often operate at several sites, in both the NHS and private sectors.

   Activity that takes place in another hospital should be reported separately by that hospital, in line with practice at NICOR and other English COP programme audits. The Society received its first returns from a private provider in 2015. We are actively encouraging independent hospitals who perform thoracic surgery to submit a return.

6. **Combined or multiple consultant operating**

   Some operations take place jointly with other specialties, for example chest wall resection in conjunction with plastic surgeons. These should be reported to the SCTS under the home unit of the consultant thoracic surgeon who operated.

7. **Definition of a VATS (video-assisted thoracic surgery) approach for anatomical lung resection**

   We suggest use of the CALGB 39802 trial definition [1] of the VATS approach for lobectomy, to define what constitutes a VATS approach to **any** anatomical lung resection (segmentectomy, lobectomy, pneumonectomy, *etc.*). This is the definition was supported by the Edinburgh VATS lobectomy consensus statement in 2013 [2].

   A VATS approach comprises *no use of rib-spreading; a maximum length of 8 cm for the utility incision; individual dissection of pulmonary vessels and bronchus; standard node sampling or dissection*

8. Role of unit Audit Leads

The SCTS returns are collected and reported by units, rather than by individual surgeons. We ask individual surgeons to cooperate with their local audit lead, submitting their data in good time and responding to any queries.

The SCTS Unit Audit Lead is responsible for the submission of accurate returns data to the SCTS.

In practice, the responsibility for day-to-day data collection and submission is often delegated to data management staff within hospitals. It often improves the overall quality of data to have dedicated professional data managers and so we support their input. The local Audit Lead retains overall responsibility for the accuracy of the data submitted.

9. Data checking at national level

A visual check of submitted data is made once the data is submitted. Obviously unusual data may be raised with the local audit lead for clarification. The submitting unit remains responsible for data accuracy and responding to any query.

10. Appointment of unit Audit Leads

Unit leads are appointed by local agreement between the surgeons within a unit. The contact details for the Unit Lead is forwarded to the National Audit Lead, who is responsible for maintaining a database of audit leads.

The period of appointment of unit audit leads is at the discretion of the surgeons in that unit.

Individual surgeons who wish to query the appointment of their unit audit lead should initially raise this within their own unit's clinical management structure.

Where units cannot, after internal discussion, agree on a unit audit lead, the SCTS Thoracic Subcommittee can be invited to mediate by the surgeons of a local unit.

Doug West

Thoracic Audit Lead

June 2016

e-mail queries to: ubh-tr.SCTSthoracicaudit.nhs.uk or doug.west@bristol.ac.uk

1. Swanson SJ, Herndon JE 2nd, D'Amico TA, et al. Video-assisted thoracic surgery lobectomy: report of CALGB 39802--a prospective, multi-institution feasibility study. *Journal of Clinical Oncology*. 2007; **25**: 4993-7.
2. Yan TD, Cao C, D'Amico TA, et al. Video-assisted thoracoscopic surgery lobectomy at 20 years: a consensus statement. *European Journal of Cardiothoracic Surgery*. 2014; **45**: 633-9.

3. National minimum dataset for thoracic surgery and lung cancer surgery

This appendix comprises the data dictionary and instructions for submission to the SCTS thoracic database project reported in Section 2. Revised April 2009.

Presented to SCTS 2004 and at subsequent meetings of the Thoracic Surgical Forum with a mandate to continue the project.

The ground rules and guiding principles

The data can be collected.

- within a Dendrite environment,
- or on Tomcat,
- or by any suitable local arrangement,
- or onto an Excel spread sheet (as supplied herewith),
- or configured as an Access database locally.

A hospital IT system should enable users to capture case numbers and dates of birth, admission, procedure and discharge without double entry.

There will be great advantages in using a user-friendly front end such as Dendrite because the straight listing in the spread sheet is potentially confusing. However any practiced data handler will find the spread sheet approach easy to deal with once the fields are understood.

The *unit of entry* is an operative episode but this may include more than one procedure. Thus if the patient has any combination of.

- bronchoscopy / mediastinoscopy / lung resection.
- VATS / thoracotomy.

the individual procedures are recorded and can be retrieved but are within the operative episode.

Most entries will be 1 for the item if applicable (*e.g.,* lobectomy done as a named operation, steroid therapy, PET scan carried out). There is no need for *0* or *N*.

Numeric values (*e.g.,* % predicted FEV1, weight) should be entered directly. If a date is required enter DDMMYYYY.

Data definitions

1. **Centre identification.** Enter as text or as pre-defined code. This should be an automatic part of a local system.
2. **Surgeon identifier.** Consultant surgeon GMC number. Required for revalidation issues.
3. **NHS number.** Enter as 10 digit number with no spaces or import from hospital PAS. This will enable tracking to death certification.
4. **Hospital number.** Until we all use NHS numbers this will be needed to send back to you cases for data verification etc. Enter in local format or import from Hospital PAS.
5. **Post code.** This has two purposes. One is that you know where your cases come from. The other is that any secondary use for research will allow us to link to deprivation indices.
6. **Date of birth.** Enter as DDMMYYYY or import from Hospital PAS. Used to calculate age in years at surgery by subtracting from Date of Operation.
7. **Sex.** M or F.
8. **Date of operation.** Date on which primary procedure takes place - enter as DDMMYYYY. This dataset is built around a surgical procedure.
9. **Time of operation.** Refers to time operation commences. Enter in 24-hour format e.g., 1335.
10. **Date of surgical referral** (DDMMYYYY).
11. **Date of first surgical assessment** (DDMMYYYY).

Operative priority

Select a single choice (enter 1) from.

12. **Elective:** booked admission for surgery.
13. **Urgent:** decision to operate on next available list.
14. **Emergency:** operation arranged outside scheduled lists.

Surgical strategy

Reasons for the operation taking place. There may be more than one, so enter 1 to each that applies.

15. **Diagnostic:** to diagnose the condition.
16. **Staging or assessment:** to stage a neoplasm or to assess the progress of the condition.
17. **Therapeutic:** to cure, alleviate or palliate.

More than one is allowed, for example:

- Mediastinoscopy - maybe diagnostic and / or staging.
- VATS pleural biopsy and talc pleurodesis - diagnostic and therapeutic.
- Thoracotomy, frozen section of nodes and tumour, and lobectomy - diagnostic, staging and therapeutic.

Pathological category

This is the pathological category (based on what used to be called the *surgical sieve*) of the aetiology of the condition for which surgery is being performed. It includes specific commonly occurring thoracic diagnoses. The field should be entered at the time of surgery and revised as necessary in the light of information from pathology at the time of discharge. Multiple answers are allowed. Enter *1* to all that are applicable.

18. **Congenital.**
19. **Trauma / accident.**
20. **Primary cancer lung** (known or probable)**.**
21. **Upper GI cancer.**
22. **Mesothelioma.**
23. **Other primary thoracic malignancy.**
24. **Malignant disease other** (secondary, recurrent or metastatic)**.**
25. **Carcinoid.**
26. **Benign neoplasms.**
27. **Empyema** (include all aetiologies of pleural sepsis)**.**
28. **Parenchymal lung disease** (as the pathology of interest - not comorbidity)**.**
29. **Vascular lesion.**
30. **Pneumothorax.**
31. **Pleural effusion.**
32. **Other** (write in)**.**

An example of a multiple entry would be an empyema where the initiating problem was trauma (stabbing for example). Both are worth retrieving to count trauma and to count empyema so enter both. The data analyst can recognise that the operative episode was single.

Procedure type

Multiple entries are appropriate if performed in the same session. Select the options that best describe the operation as a whole - if there was more than one procedure, enter each. The data analyst can see that they are part of a single operative episode. Enter *1* if applicable.

33. **Endoscopy** (bronchoscopy / oesophagoscopy +/- biopsy)**.**
34. **Endoscopy** (bronchoscopy / oesophagoscopy + any other procedure)**.**
35. **Drain insertion.**
36. **Other minor procedure** (of the scale of node biopsies)**.**
37. **Mediastinoscopy and / or mediastinotomy.**
38. **Other intermediate procedure** (of a similar order of magnitude to a rib resection)**.**
39. **VATS.**
40. **Thoracotomy.**
41. **Median sternotomy.**
42. **Other major incision.**

Primary organ / System targeted

Select the main target organ(s) of the operation. This is an anatomical list.

More than one may be entered (*e.g.,* lung and trachea / main bronchi for bronchoplastic lung resections) but coincidental surgery, such as chest wall if that is purely the route of access, or main bronchus division for a simple pneumonectomy will not be helpful in data analysis. Enter *1* if applicable.

43. **Aorta and / or great vessels.**
44. **Chest wall.**
45. **Diaphragm.**
46. **Lung.**
47. **Mediastinum.**
48. **Oesophagus.**
49. **Pericardium.**
50. **Pleura.**
51. **Thymus.**
52. **Thyroid.**
53. **Trachea and / or main bronchi.**
54. **Other.**

Named operations

Select the procedure(s) performed at this operation. Thus pleural biopsy and pleurodesis can both be entered. This is not a comprehensive list but is designed to capture the commonest and most well-defined operations. Enter 1 if applicable.

55. **Lobectomy / bilobectomy** (any indication)**.**
56. **Lobectomy / bilobectomy** (complex) **with chest wall resection, airway resection etc.**
57. **Pneumonectomy** (any indication)**.**
58. **Sub lobar lung resection wedge or segmentectomy.**
59. **Mediastinoscopy / mediastinotomy.**
60. **Pneumothorax surgery** (any technique)**.**

61. **Lung volume reduction.**
62. **Bullectomy.**
63. **Pleurodesis.**
64. **Pleural biopsy** (any technique)**.**
65. **Decortication.**
66. **Upper GI resection** (any)**.**
67. **Hiatus hernia surgery** (any)**.**
68. **Pectus surgery.**
69. **Sympathectomy.**
70. **Thymectomy for myasthenia.**
71. **Thymectomy for thymoma.**
72. **Thyroid surgery.**
73. **Bronchoscopy.**
74. **Oesophagoscopy.**
75. **Chest drain insertion.**
76. **Other** (enter text)**.**

Pre-operative risk factors

Although previously required only for lung cancer resections, we feel that this information is useful for all thoracic procedures. If available it should be entered for all procedures.

Pulmonary

77. **Measured FEV1.**
78. **% Predicted FEV1.**
79. **Measured FVC.**
80. **% Predicted FVC.**
81. **Diffusion capacity** (% predicted KCO)**.**
82. **Never smoked** (Enter "1" if applicable)**.**
83. **Pack years.**
84. **Dyspnoea score.** Grade 1 = dyspnoea on strenuous exercise, 2 = when hurrying or walking uphill, 3 = Walks slower than contemporaries on level ground because of breathlessness or has to stop for breath when walking at own pace, 4 = Stops for breath after walking about 100 meters or after a few minutes on level ground, 5 = Too breathless to leave the house or breathless when dressing or undressing.
85. **COPD.** FEV1 / FVC ration <0.7 after bronchodilator therapy.

Non pulmonary

86. **Height.** Patient's height in centimetres - enter as whole number.
87. **Weight.** Patient's weight in kilograms - enter to one decimal place.
88. **Urea** (mmol ℓ^{-1})**.**
89. **Creatinine** (μmol ℓ^{-1})**.**
90. **Hb** (g dℓ^{-1})**.**
91. **Insulin dependent diabetes.**

92. **Ischaemic heart disease.**

93. **Cardiac failure.**

94. **Previous stroke.**

95. **Steroid therapy.**

96. **Anticoagulation with warfarin or equivalent therapy.**

97. Performance status (ECOG)

98. **ASA Grade.** American Society of Anaesthetists grade.

99. **Previous cancer of history.** Includes cancers treated many years previously. But does not include non-melanoma skin cancer or premalignant conditions such as cervical dysplasia or Barrett's disease.

100. **Hypertension.** Treated, or higher than 140/90 on more than one occasion.

101. **Peripheral vascular disease.** Carotid occlusion or >50% stenosis; previous or planned surgery on abdominal aorta, limb arteries or carotids.

102. **Alcoholism.**

103. **Hyperlipidaemia.** Treated, or current or previous cholesterol >5.2 mmol/l.

Lung cancer surgery

104. **Is this operation a resection for primary lung cancer?** Enter 1 for yes or leave blank for no. If the answer is **No** proceed to discharge section. If the answer is **Yes** please answer the specialised questions for lung cancer surgery. Omit where data is not available. Do not estimate. If the data is too incomplete to analyse it is better that we know that.

Pre-Operative primary lung cancer diagnostic staging tests

Enter 1 if applicable (*i.e.,* if the test has been carried out as part of pre-operative staging).

105. **CT.**

106. **MRI.**

107. **PET.**

108. **Pre-operative tissue diagnosis made** (by any method e.g., bronchoscopy, CT guided core biopsy or FNA, EBUS etc.). Enter 1 for yes, leave blank for no.

Primary lung cancer histological diagnosis

Update after surgery if it changes. This is not an audit of the pre-operative diagnostic accuracy. The definitive histology is what we need. Enter 1 if applicable.

109. **Small cell.**

110. **NSCLC.**

111. **Squamous.**

112. **Adeno.**

113. **Undifferentiated.**

114. **Broncheoalveolar.**

115. **Other or further information** (write in).

Primary lung cancer pre-operative staging

116. **T stage.**

117. **N stage.**

118. **M stage.**

Primary lung cancer neoadjuvant therapy

Enter *1* if applicable.

119. **Chemotherapy preop.**
120. **Radiotherapy preop.**

Primary lung cancer surgical resection performed

Combinations are allowed to make up pneumonectomies, or lobectomy plus part of adjacent lobe. Enter *1* to all that are applicable.

121. **Frozen section taken for diagnosis.**
122. **Frozen section for staging.**
123. **Left upper lobe.**
124. **Left lower lobe.**
125. **Right upper lobe.**
126. **Middle lobe.**
127. **Right lower lobe.**
128. **Sublobar resection** (whether wedge or segment)**.**

Primary lung cancer pathological (post-op) TNM staging

129. **T stage.**
130. **N stage.**
131. **M stage.**

Discharge data

132. **No complications.** Enter 1 if applicable. If the patient suffered any complications then leave blank.
133. **Date of ITU readmission.** Only include admissions because of complications as opposed to the elective use of ITU or HDU after surgery.
134. **Date of discharge from ITU.** As above.
135. **IPPV.** Enter 1 if applicable. Again only applies to complications as opposed to elective ventilation as part of primary surgery.
136. **Air leak >7 days.** Enter 1 if applicable.
137. **Infection requiring extension of hospital stay.** Enter 1 if applicable.
138. **Return to theatre within the same admission.** Enter 1 if applicable. Do not include suction bronchoscopy or insertion of chest drain.
139. **Date of discharge / transfer / death.**
140. **Death.** Enter 1 if applicable

4. Cardiothoracic units in England

Code	Hospital	NHS Trust
R1H	St Bartholomew's Hospital	Barts Health NHS Trust
RA7	Bristol Royal Infirmary	University Hospital Bristol NHS FT
RBQ	Liverpool Heart and Chest Hospital	Liverpool Heart & Chest NHS FT
RDD	Basildon and Thurrock University Hospitals	Basildon and Thurrock University Hospital NHS FT
RGM	Papworth Hospital	Papworth Hospital NHS FT
RH8	Royal Devon & Exeter Hospital	Royal Devon & Exeter NHS Trust
RHM	Southampton General Hospital	University Hospital Southampton NHS FT
RHQ	Northern General Hospital	Sheffield Teaching Hospitals NHS FT
RJ1	Guy's Hospital	Guy's and St Thomas' NHS FT
RJ7	St George's Hospital	St George's Healthcare NHS Trust
RJE	Royal Stoke University Hospital	University Hospital of North Midlands NHS Trust
RJZ	King's College Hospital ♥	King's College Hospital NHS Foundation Trust
RK9	Derriford Hospital	Plymouth Hospitals NHS FT
RKB	University Hospital (Coventry)	University Hospitals Coventry & Warwickshire NHS Trust
RL4	New Cross Hospitals	The Royal Wolverhampton Hospitals NHS Trust
RM1	Norfolk and Norwich University Hospital	Norfolk and Norwich University Hospitals NHS FT
RM2	Wythenshawe Hospital	University Hospital of South Manchester
RR1	Heartlands Hospital	Heart of England NHS Trust
RR8	St. James' Hospital	Leeds Teaching Hospitals
RRK	Queen Elizabeth Hospital ♥	University Hospitals Birmingham NHS FT
RRV	University College Hospital	University College London Hospitals NHS FT
RT301	Harefield Hospital	Royal Brompton & Harefield Hospitals
RT302	Royal Brompton Hospital	Royal Brompton & Harefield Hospitals
RTD	Freeman Hospital	The Newcastle Upon Tyne Hospitals NHS FT
RTH	John Radcliffe Hospital	Oxford University Hospitals NHS Trust
RTR	The James Cook University Hospital	South Tees Hospital NHS FT
RW3	Manchester Royal Infirmary ♥	Central Manchester University Hospitals NHS FT
RWA	Castle Hill Hospital	Hull and East Yorkshire Hospitals NHS Trust
RWE	Glenfield Hospital	University Hospitals of Leicester NHS Trust
RX1	Nottingham University Hospitals NHS Trust	Nottingham University Hospital NHS Trust
RXH	Royal Sussex County Hospital ♥	Brighton & Sussex University Hospitals NHS Trust
RXL	Blackpool Victoria Hospital	Blackpool Teaching Hospitals NHS FT
RYJ	Hammersmith Hospital	Imperial College Healthcare NHS Trust

FT Foundation Trust
♥ Cardiac units only

5. Methods for analysis of thoracic surgery

Principal OPCS procedure codes for thorax procedures

Code	Description
T011	Thoracoplasty
T012	Removal of plombage material from chest wall
T013	Excision of lesion of chest wall
T018	Other specified partial excision of chest wall
T019	Unspecified partial excision of chest wall
T071	Decortication of pleura
T072	Open excision of lesion of pleura
T078	Other specified open excision of pleura
T079	Unspecified open excision of pleura
T081	Resection of rib and open drainage of pleural cavity
T082	Closure of open drainage of pleural cavity
T083	Fenestration of pleura
T084	Closure of fenestration of pleura
T088	Other specified open drainage of pleural cavity
T089	Unspecified open drainage of pleural cavity
T091	Open destruction of lesion of pleura
T092	Open biopsy of lesion of pleura
T093	Mechanical open pleurodesis
T094	Chemical open pleurodesis
T095	Open pleurodesis NEC
T098	Other specified other open operations on pleura
T099	Unspecified other open operations on pleura
T101	Endoscopic extirpation of lesion of pleura
T102	Endoscopic pleurodesis using talc
T103	Endoscopic pleurodesis NEC
T108	Other specified therapeutic endoscopic operations on pleura
T109	Unspecified therapeutic endoscopic operations on pleura
T111	Diagnostic endoscopic examination of pleura and biopsy of lesion of pleura
T112	Diagnostic endoscopic examination of pleura and biopsy of lesion of intrathoracic organ NEC
T118	Other specified diagnostic endoscopic examination of pleura
T119	Unspecified diagnostic endoscopic examination of pleura
T121	Drainage of lesion of pleura NEC
T122	Drainage of pleural cavity NEC
T123	Aspiration of pleural cavity
T124	Insertion of tube drain into pleural cavity
T128	Other specified puncture of pleura
T129	Unspecified puncture of pleura
T131	Insufflation of talc into pleural cavity NEC
T132	Introduction of sclerosing substance into pleural cavity NEC
T133	Introduction of cytotoxic substance into pleural cavity
T134	Introduction of therapeutic substance into pleural cavity
T138	Other specified introduction of substance into pleural cavity
T139	Unspecified introduction of substance into pleural cavity
T141	Percutaneous biopsy of lesion of pleura
T148	Other specified other operations on pleura
T149	Unspecified other operations on pleura

Principal ICD-10 diagnosis codes used for selection of patients undergoing thorax procedures into analysis cohort

Code	Description
A16	Tuberculosis
J86	Pyothorax
J93	Pneumothorax
J94	Other pleural conditions

Separate logistic regression models were created for the risk adjustment process. The model for the adjustment of 30-day post-operative mortality after pneumothorax included: type of pneumothorax, age, comorbidity, admission method and type of trust. The discrimination has an ROC of 0.83.

The model for empyema procedures included type of empyema, type of surgery, age and comorbidity. The discrimination has an ROC of 0.83.

The models for the adjustment of the 30-readmission rate after pleurodesis for pneumothorax included type of pneumothorax, type of surgery, age, type of trust and type of admission. The discrimination has an ROC of 0.67.

The calibration graphs for the logistic regression models used to adjust post-operative mortality are presented.

Fig. 9.07 **Pneumothorax pleurodesis : Predicted *versus* observed mortality for procedures in all trusts**

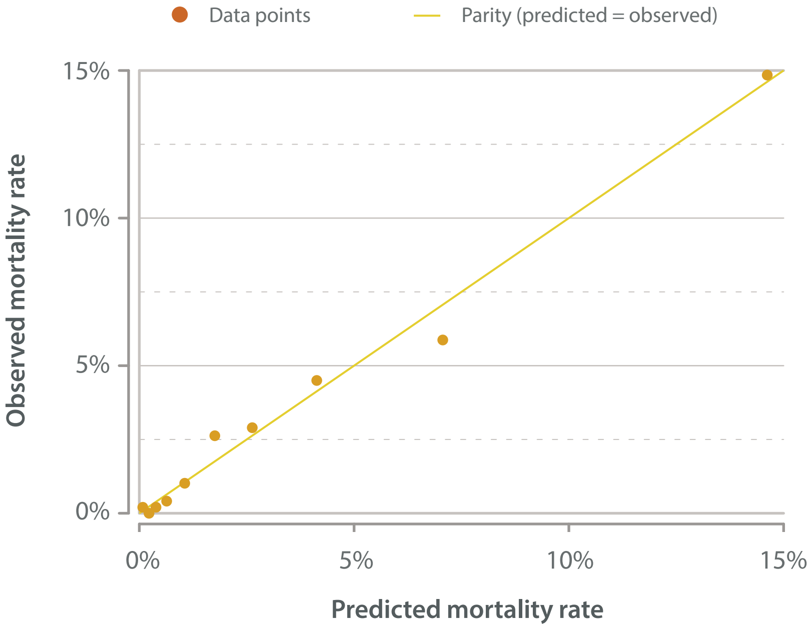
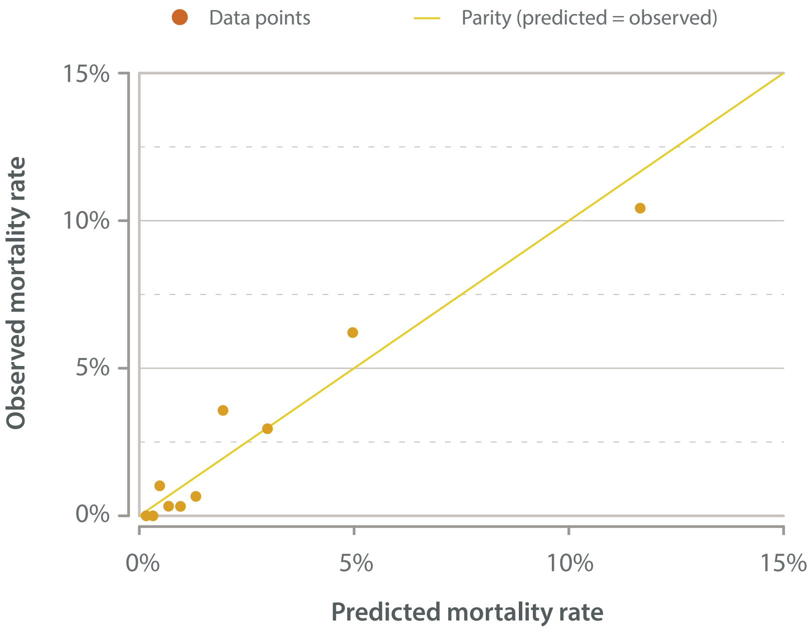


Fig. 9.08 **Empyema : Predicted *versus* observed mortality for procedures in all trusts**



6. Individual provider-level statistics for pneumothorax and empyema surgery

Surgical activity

	Surgery					
	Pneumothorax				Empyema	
Unit	Pleurodesis count	Open excision count	Median LOS / days	IQR LOS / days	Drains count	Open excision count
R1H	76	93	5	4-10	3	50
RA7	83	259	3	2-6	106	67
RBQ	69	435	4	3-6	10	83
RDD	68	107	4	3-8	3	57
RGM	118	145	4	2-6	36	54
RH8	167	1	4	3-7	41	34
RHM	240	139	4	3-6	63	89
RHQ	77	207	5	4-6	25	198
RJ1	306	298	5	4-7	22	148
RJ7	316	54	4	3-6	8	43
RJE	44	136	4	3-7	2	43
RK9	56	105	5	5-7	32	53
RKB	17	108	4	3-6	2	29
RL4	14	104	3	3-5	9	72
RM1	16	195	6	4-8	16	82
RM2	223	234	4	3-6	21	79
RR1	60	270	4	3-6	10	47
RR8	422	38	4	3-6	137	127
RRV	342	39	5	3-7	26	89
RT3	400	87	5	3-7	115	130
RTD	209	101	5	3-8	52	36
RTH	117	88	4	3-7	11	54
RTR	107	13	4	3-6	99	13
RWA	77	105	5	3-9	13	37
RWE	155	246	4	3-6	10	247
RX1	51	190	5	4-7	13	113
RXL	89	122	5	3-7	2	38
RYJ	182	66	5	4-8	9	66

For pneumothorax

Unit	Total activity	Risk-adjusted outcome rates: 30-day in-hospital mortality	30-day readmission	1-year readmission (same side)
R1H	169	2.6%	8.8%	12.0%
RA7	342	1.7%	12.0%	17.5%
RBQ	504	2.0%	8.8%	9.1%
RDD	175	1.8%	12.2%	17.7%
RGM	263	0.0%	9.8%	19.6%
RH8	168	2.8%	8.4%	15.3%
RHM	379	1.8%	10.6%	16.5%
RHQ	284	0.0%	11.3%	18.6%
RJ1	604	2.3%	10.6%	15.0%
RJ7	370	3.2%	5.4%	7.6%
RJE	180	3.7%	14.6%	16.2%
RK9	161	1.9%	10.1%	8.0%
RKB	125	4.4%	10.7%	11.2%
RL4	118	3.7%	9.7%	5.8%
RM1	211	0.0%	14.4%	10.2%
RM2	457	2.1%	8.1%	10.3%
RR1	330	5.7%	12.1%	16.7%
RR8	460	2.1%	11.5%	11.6%
RRV	381	1.7%	7.5%	12.1%
RT3	487	1.3%	9.0%	13.2%
RTD	310	1.6%	10.3%	13.2%
RTH	205	1.8%	10.7%	11.0%
RTR	120	1.3%	11.3%	9.6%
RWA	182	0.0%	14.2%	7.0%
RWE	401	1.4%	10.4%	12.6%
RX1	241	5.7%	7.1%	10.0%
RXL	211	2.0%	16.2%	17.0%
RYJ	248	1.4%	10.4%	10.9%

For empyema

Unit	Total activity	LOS (days) Median	LOS (days) IQR	Risk-adjusted outcome rates: 30-day in-hospital mortality	Risk-adjusted outcome rates: 30-day readmission
R1H	53	7	5-17	6.1%	10.2%
RA7	173	9	5-19	3.0%	10.2%
RBQ	93	6	4-8	3.9%	15.2%
RDD	60	7.5	5-13	0.0%	12.9%
RGM	90	8.5	5-17	3.7%	8.8%
RH8	75	8	5-14	3.1%	5.1%
RHM	152	7.5	5-17.5	1.2%	16.5%
RHQ	223	8	6-15	3.1%	11.2%
RJ1	170	8.5	6-18	1.4%	11.7%
RJ7	51	7	6-14	7.9%	10.8%
RJE	45	6	5-11	3.8%	5.1%
RK9	85	8	5-15	3.0%	16.3%
RKB	31	7	4-13	4.5%	10.4%
RL4	81	5	4-9	1.7%	16.2%
RM1	98	9	6-16	3.9%	12.7%
RM2	100	8	6-16	1.1%	13.2%
RR1	57	6	5-13	0.0%	17.8%
RR8	264	6	4-10	3.8%	9.6%
RRV	115	6	4-12	2.3%	11.9%
RT301	245	8	5-15	2.0%	12.2%
RTD	88	7.5	5-16	3.0%	19.5%
RTH	65	9	5-21	1.7%	23.6%
RTR	112	6	4-10	1.7%	14.6%
RWA	50	8	6-12	6.2%	17.3%
RWE	257	6	5-13	1.5%	13.4%
RX1	126	8	6-14	2.6%	16.0%
RXL	40	9	6-12.5	0.0%	14.1%
RYJ	75	9	6-17	0.0%	6.8%

The Society for Cardiothoracic Surgery in Great Britain & Ireland's Third National Thoracic Surgical Report

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