The Effects of Increased Provision of Thoracic Surgical Specialists on the Variation in Lung Cancer Resection Rate in England

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Introduction: There is a wide variation in the lung cancer resection rate in England. We assessed the effect of the regional provision of thoracic surgery service on the variation in lung cancer resection rate.

Methods: A retrospective observational study correlating National Lung Cancer Audit data with thoracic surgery workforce data was performed to review the lung cancer resection rate in England in 2008 and 2009.

Results: In 2008, there was a sixfold variation in resection rate, with a higher resection rate in hospitals where surgeons were based (base hospitals) than in peripheral hospitals (20.0% versus 11.6%, $p < 0.001$). The resection rate was also higher in cancer networks, which were served by two or more specialist thoracic surgeons (14.6% versus 12.7%, $p = 0.028$), and where surgeons were present in more than two-thirds of the lung cancer multidisciplinary team meetings (14.4% versus 12.0%, $p = 0.046$). In 2009, the overall resection rate increased from 14.5% to 18.4%. Four units increased their number of specialist thoracic surgeons and had a significantly higher increase in resection rate than units without expansion (relative rise 66.3% versus 19.2%; $p = 0.022$).

Conclusions: The large variation in the resection rate seems, in part, to be related to the local availability of specialist thoracic surgeons. The greatest improvement in the resection rate was in units with expansion of specialist thoracic surgeons. We suggest the expansion of specialist thoracic surgeons will improve the resection rate and thereby the overall survival of lung cancer in England. This has significant implications for the future of training in cardiothoracic surgery and organization of cancer services.

Key Words: Non–small-lung cancer, Resection rates, Thoracic surgeon.

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Lung cancer is the leading cause of cancer death in the United Kingdom. Despite the ambitions of the National Health Service Cancer Plan for England in 2000[1] to bring cancer survival up to the level of the best countries by 2010, the United Kingdom continues to have the poorest lung cancer survival among developed nations.[2] Patients who undergo curative resection have the best chance of long-term survival, and there is evidence from the United Kingdom linking higher resection rates with better survival rates.[3] Therefore, it is not surprising that the lung cancer resection rate in the United Kingdom has been significantly below that of most other countries.[4,5] This was recognized by the British Thoracic Society and the Society of Cardiothoracic Surgeons, whose recommendations included the increased provision of thoracic surgeons.[6] The number of lung resections for primary cancer in the United Kingdom and Ireland as identified by the Society for Cardiothoracic Surgery (SCTS) register increased from 3112 in 2001-2002 to 5265 in 2009-2010. This represented an increase in resections of almost 60%, with a reduction in the operative mortality for lung cancer resections from 3.8% to 2.1%.[7] Although the resection rate in England has improved over the years, it remains below that of the United States and many parts of Europe.[8]

Within the United Kingdom, the geographical variation in lung cancer resection rate is even more striking, despite adjusting for case-mix factors including age, stage, performance status and socioeconomic status,[8] there is a threefold variation in survival and sixfold variation in resection rate depending on where one lives. Data from the National Lung Cancer Audit have also been used to analyze resection rates by characteristics of treatment center. Rich et al.[9] have demonstrated a more than 50% higher resection rate for patients who were first seen in a center that has cardiothoracic surgery on site after adjusting for the Charlson comorbidity index and the case-mix factors mentioned above. The aim of the study was to test the hypothesis that resection rate is limited by the availability of specialist thoracic surgeons and explore how the variation of the resection rate is related to the characteristics of the surgical workforce.

MATERIALS AND METHODS

Lung Cancer Service Organization

Secondary care lung cancer services in the NHS in England were delivered through 159 acute hospital trusts

during the period of study. For the purpose of cancer services, these trusts were organized into 28 cancer networks. Thirty-two hospital trusts (hereafter referred to as *base* hospitals) provided lung cancer surgery through both cardiothoracic surgeons and specialist thoracic surgeons. Apart from serving their own specialist teams, the base hospitals provided surgical support to the lung cancer multidisciplinary teams (MDTs) of the surrounding peripheral hospitals, where they also held outpatient clinics. Lung cancer MDTs in the United Kingdom currently comprises thoracic surgeons, respiratory physicians, radiologists, oncologists, pathologists, lung cancer nurse specialists, and palliative care clinicians.

National Lung Cancer Audit Database

The National Lung Cancer Audit is a register of newly diagnosed lung cancer patients, processes, and outcomes in the United Kingdom. It is jointly run by the Royal College of Physicians and the Information Centre for Health and Social Care. The first full year of data collection was 2005; this data set contained 112 fields, covering patient demographics, clinicopathologic and process-of-care variables. In 2008, all but three hospital trusts and all cancer networks participated and submitted their data to the audit. The database captured 94% of expected lung cancer cases presenting to secondary care. By 2009, all but one hospital trust participated, and the database is believed to have captured almost all lung cancer cases presenting to secondary care. Histological diagnosis was pursued in patients who were fit to undergo treatment on the basis of performance status and fitness, whereas frail and unfit patients were coded as lung cancer on the basis of clinicoradiological correlation, by the MDT. We adopted the definition of resection rate as the number of patients undergoing surgical resection out of those with histologically confirmed non–small-cell lung cancer (NSCLC) patients. This definition allows standardized comparison with published data from the United States and Europe.[10]

U.K. Cardiothoracic Surgery Workforce Data

Manpower data for cardiothoracic surgery was obtained from the Specialist Advisory Committee, the SCTS, and the Center for Workforce Intelligence. Cardiothoracic surgeons were defined as those surgeons whose practice comprised of both cardiac and thoracic surgery. Surgeons were considered to be specialist thoracic surgeons if their practice included only thoracic (noncardiac) surgery.

Data on the surgical attendance at MDT was obtained through the peer review process of the MDTs.[11] We correlated the resection rate in England during the audit periods of 2008–2009 with manpower data from this period. We investigated whether resection rate was related to the following variables: caseload of the trust, the availability of surgeons as a whole and in particular specialist thoracic surgeons, their attendance at lung MDTs, and the effects of increasing the number of specialist thoracic surgeons in the workforce.

Statistical Methods

Statistical analysis was carried out with SPSS version 16.0 (SPSS, Chicago, IL). Correlations between nonparametric continuous variables were evaluated with Pearson's correlation coefficient. Nonparametric variables are expressed as median (interquartile range). Significance of intergroup difference was evaluated in nonparametric variables by the Mann–Whitney *U* test and Wilcoxon sign-ranked tests, with the exact method.

RESULTS

Resection Rate

In England, in 2008, there were 21,586 cases of lung cancer (excluding histologically confirmed cases of small-cell lung cancer). Of these, 14,662 cases were histologically confirmed NSCLC whereas the remainder were clinical diagnoses. Among these, 2123 patients (14.5%) underwent surgery with curative intent. In 2009, the number of recorded cases increased to 25,029. Of these, 17,948 cases were histologically confirmed NSCLC, and 3308 patients (18.4%) underwent surgery with curative intent. This represented a 56% increase in the number of resections and a 26.9% increase in the resection rate.

Effect of Caseload

We correlated the number of NSCLC cases recorded with the resection rate for each trust. There was no correlation between caseload and resection rate *($r = 0.017$)* (Fig. 1).

Effects of Availability of Thoracic Surgery

The resection rates were found to be higher in patients seen in base hospital trusts than in peripheral trusts (base hospital resection rate 20% (interquartile range [IQR] 13.8%-21.6%) versus peripheral hospitals 11.6% (7.9%-17.5%), $p < 0.001$ (Table 1).

Despite being served by the same surgical team, the resection rate was higher for lung MDTs in the base hospitals

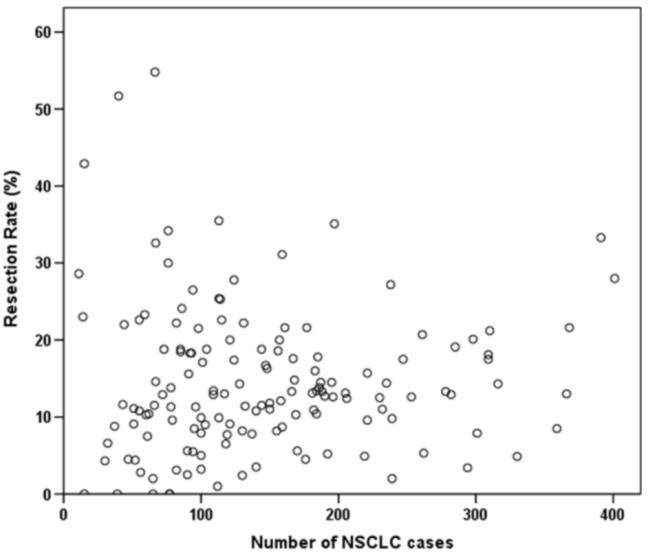

FIGURE 1. The effect of volume and resection rates across England. Units with higher volume did not have a corresponding higher resection rate.

TABLE 1. Effect of Local Availability of Thoracic Services–Comparison of all Base and All Peripheral Units across England

	Base Hospitals %	Peripheral Hospitals %	*p*
Resection rates: median (interquartile range)	20 (13.8–21.6)	11.6 (7.9–17.5)	<0.001

than for MDTs in their respective peripheral hospitals (median resection rate for base hospital 18.5% (IQR 15.6%-21.6%) versus peripheral hospitals 13.2% (7.6%-16.1%, $p < 0.001$) (Table 2).

Of the 32 base hospitals, 18 had one or no specialist thoracic surgeons, whereas 14 had two or more specialist thoracic surgeons. Networks served by two or more specialist thoracic surgeons performed more operations for NSCLC than the remainder (median 116 (IQR 61-167) versus 62 (41-84), $p = 0.011$). They also had a higher resection rate (median 14.6% (IQR 13.3%-16.8%) versus 12.7% (9.1%-14.9%), $p = 0.028$, (Table 3)).

Data on surgical attendances at MDT were obtained for 132 (83%) trusts. Of these MDTs, surgeons (cardiothoracic or specialist thoracic) were present in more than two-thirds of the meetings in 71 trusts (53.6%). These trusts had a higher resection rate than those where surgeons were present in less than two-thirds of the meetings (median 14.4% [IRQ, 9.1%–21.6%] versus 12.0% [9.0%–18.1%], $p = 0.046$).

Effect of Increasing Thoracic Surgical Capacity

In 2009, four base hospitals appointed additional specialist thoracic surgeons. MDTs served by these units experienced a larger growth in surgical activity than in the remainder (median growth in number of resections 96.4% versus 42.3%, $p = 0.06$). The resection rate also rose significantly more in the networks they served (median relative rise in resection rate 66.3% [interquartile range, 39.5%–91.3%], versus 19.2% [interquartile range, 4.2%–48.8%], $p = 0.022$).

DISCUSSION

Principal Findings

We found no correlation between resection rate and local caseload—busy units did not necessarily have higher rates. The lung cancer resection rate was however associated both with the accessibility to and the provision of specialist thoracic surgeons. The presence of a surgeon at the lung MDT, where the management of all new lung cancer cases is discussed, is imperative. It is no coincidence that the resection rates are higher in the base hospitals as these are invariably well attended by the surgeons who work in these units. When those surgeons are able to attend regularly at MDTs in peripheral hospitals, their resection rates also increase as a consequence. The provision of specialist thoracic surgeons provided an even greater boost to the resection rate. Rates were already higher where two or more thoracic surgical specialists served a network and an even greater increase was seen when new specialists were employed.

TABLE 2. Effect of Local Availability of Thoracic Services–Comparison of Resection Rates of Base versus Peripheral Units Matched within Each Network

	Base Hospital %	Peripheral Hospital %	*p*
Resection rate within each network: median (interquartile range)	18.5 (15.6–21.6)	13.2 (7.6–16.1)	<0.001

TABLE 3. Effect of Number of Specialist Thoracic Surgeons on the Workload of Each Network

	≥ 2 Specialist Thoracic Surgeons	≤ 1 Specialist Thoracic Surgeon	*p*
Number of operations median (interquartile range)	116 (61–167)	62 (41–84)	0.011
Resection rate median (interquartile range)	14.6% (13.3%–16.8%)	12.7% (9.1% –14.9%)	0.028

Comparison with Other Studies

Previous reports have found that the implementation of central referral pathways and MDTs boosted the resection rate substantially to over 20% within a short period of time.[12–15] However, the U.K. resection rate has improved[8] but still remains lower than many other countries, despite having universally established the MDT approach as a standard procedure. This study has demonstrated that it is the constitution rather than just the existence of a lung cancer MDT, which is important.

Our findings of a higher resection rate in base or surgical centers than in peripheral or nonsurgical centers echo those of Rich et al.[9] The authors found that a patient first seen at a base hospital was 51% more likely to undergo surgery than if they were first seen at a peripheral hospital, a figure adjusted for a range of case-mix factors including age, stage, and comorbidity. They did not identify what features of a *surgical center* drove the increase in resection rate, nor did they differentiate between the presence of cardiothoracic and specialist thoracic surgeons.

We have previously shown that the resection rate of a unit could be doubled with the addition of a specialist thoracic surgeon.[15] In that series, the increase was attributed to more surgery in older, higher-risk patients facilitated by the increased use of more specialized techniques, that is, video-assisted thoracic surgery lobectomy and sleeve resection. These findings could be extrapolated across England to account for the variation in the resection rates between centers with specialist thoracic surgeons and a higher resection rate and other centers.

There is already evidence that a change in attitude toward the operative risk versus benefit ratio is pushing the resection rate up.[8] However, there is still room for improvement nationally as there is evidence that the elderly female population is less likely to get histocytological confirmation and anticancer treatment.[16] Such variation could account for

differences in resection rates between centers with specialist thoracic surgeons and other centers.

Our results raise the possibility that the availability of thoracic surgical manpower is the main limiting factor for resection rate. Manpower data from countries with higher resection rates support this. In England and Wales there are approximately 67 thoracic specialists and 63 cardiothoracic surgeons (Centre for Workforce Intelligence, 2010) offering approximately 90 whole-time equivalents or 1:700,000 population. The U.S. coverage is 1:100,000,[17] which is an underestimate as it excludes general surgeons who also regularly undertake lung resections there. The coverage in Canada lies between 1:150,000 and 1:500,000,[18] whereas in Australia it is 1:250,000.[19] This suggests a stark underprovision of thoracic surgery in the United Kingdom.

One solution would be to centralize services to consolidate the greater experience and expertise of thoracic surgical specialists.[9] Indeed, there has been a small reduction in the number of MDTs in England, from 175 in 2006, to 158 in 2011.[11] However, this could be disadvantageous to the more outlying centers and may actually increase geographical variation and inequality. There is evidence that socially disadvantaged patients who live further from specialist centers have lower treatment rates.[20] An alternative would be to continue to increase thoracic surgical specialist appointments, which would increase attendance at peripheral hospital MDTs, which our results predict, would lead to an increase in local resection rate.

Strengths and Limitations of the Study

This study is a comprehensive and unselected analysis of lung cancer surgery at a national level, and the findings should contribute to the elimination of stark health inequalities. There are a number of limitations to this study. First, the use of a resection rate, where the denominator is histologically confirmed NSCLC, is affected by how aggressive the local policy is to obtain tissue diagnosis. Previously, histology was only pursued if radical treatment was anticipated. However, with the advent of tailored biological therapies, tissue diagnosis is increasingly undertaken, even for treatments with palliative intent. This may have an effect on the denominator for resection rate, which could confound comparisons across different practices. Second, information on the reasons for non-operation in areas with a low resection rate was not assessed. An understanding of regional variations in socioeconomic status and comorbidities would help to better plan the future investment in thoracic surgery.

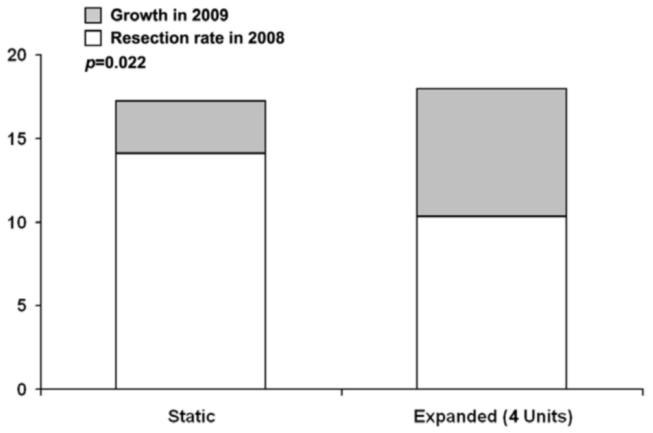

FIGURE 2. Units that expanded their provision of specialist thoracic surgeons experienced a significantly larger increase in their resection rate than units that did not expand *(p = 0.022)*.

Conclusion and Implications

We have demonstrated the link between the acknowledged geographical variations in the lung cancer resection rate in England and the local provision of specialist thoracic surgery. When considered in conjunction with the recent study[3] that has demonstrated a lower risk of death from lung cancer in populations with a higher surgical resection rate, these results have important implications for other health care systems. National strategies for lung cancer should focus on improving the resection rate by investing in the provision and training of specialist thoracic surgery.

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