ORIGINAL ARTICLE

Impact of organisation and specialist service delivery on lung cancer outcomes

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ABSTRACT

Introduction Data from the National Lung Cancer Audit (NLCA) often show variation in outcomes between lung cancer units which are not entirely explained by case mix. We explore the association between the organisation of services and patient outcome.

Methods Details of service provision were collected via an electronic survey in June 2017. An overall organisational score derived from eleven key service factors from national lung cancer commissioning guidance was calculated for each organisation. The results for each hospital were linked to their patient outcome results from the 2015 NLCA cases. Multivariate logistic regression analysis was used to link the organisational score to patient outcomes.

Results Lung cancer unit organisational audit scores varied from 0 to 11. Thirty-eight (29%) units had a score of 0–4, 64 (50%) had a score of 5–7 and 27 (21%) had a score of 8–11. Multivariate regression analysis revealed that, compared with an organisational score of 0–4, patients seen at units with a score of 8–11 had higher 1-year survival (adjusted OR (95% CI)=2.30 (1.04 to 5.08), p<0.001), higher curative-intent treatment rate (adjusted OR (95% CI)=1.62 (1.26 to 2.09), p<0.001) and greater likelihood of receiving treatment within 62 days (adjusted OR (95% CI)=1.49 (1.20 to 1.86), p<0.001).

Conclusion National variation in the provision of services and workforce remain. We provide evidence that adherence to the national lung commissioning guidance has the potential to improve patient outcomes within the current service structure.

Key messages

What is the key question?

- Is adherence to the UK national lung cancer commissioning guidance on provision of lung cancer services associated with improved patient outcomes?

What is the bottom line?

- When adjusted for patient factors, adherence to the national lung cancer commissioning recommendations is associated with higher curative-intent treatment rates, increased likelihood of patients receiving treatment within 62 days and improved 1-year survival.

Why read on?

- If all lung cancer units provided services according to the national lung cancer commissioning guidance, then improvements in patients' outcomes are likely to be achieved.

INTRODUCTION

Data from the National Lung Cancer Audit (NLCA) often show a wide variation in treatment and outcomes between individual lung cancer units, which cannot be entirely explained by variations in the type and severity of cancer cases or patient factors.[1]

The first NLCA organisational audit in 2014 highlighted significant variation in the availability and workload of lung cancer specialists, diagnostic and treatment services.[2] An association was found between on-site access to diagnostic and treatment modalities and higher resection rates.[2] This association is supported by previous studies that have shown that patients with lung cancer that are seen in a tertiary surgical centre are more likely to receive surgery.[3] In addition, patients are twice as likely to receive active treatment if they are seen by a lung cancer clinical nurse specialist (LCNS).[4 5] Furthermore, the evaluation of lung cancer diagnostic assessment programmes in the USA, where access to services are centrally organised, have demonstrated a significant reduction in pathway time.[6]

The first organisational audit made a number of recommendations, and subsequent national publications have set out key priorities for commissioning services for people with lung cancer in the UK.[7] However, there is a paucity of evidence available to underpin these recommendations.

To address this, we aimed to explore resources available for the care of patients with lung cancer and the relationship between the organisation of care with patient outcomes. Defining these factors will be critical in guiding policy about the minimum resources required for a hospital to deliver a safe and effective lung cancer service.

METHODS

NLCA organisational audit

An electronic survey was sent to all lung cancer leads in England and Wales in June 2017. The survey included questions on workforce provision, diagnostic procedures and treatment modalities. The questions were based on the 2014 survey but modified following feedback from three pilot testing sites. Accompanying help notes and a help desk were provided. The help notes specified

Table 1 Items included in the organisational score

	Score
One whole time equivalent respiratory physician direct clinical care per 200 new diagnoses per year	1
Radiologist with at least a third of their job plan devoted to lung cancer	1
Medical oncologist with at least a third of their job plan devoted to lung cancer	1
Clinical oncologist with at least a third of their job plan devoted to lung cancer	1
One WTE LCNS per 80 new diagnoses per year	1
Separate diagnostic planning multidisciplinary team meetings	1
On-site PET scan	1
On-site endobronchial ultrasound	1
On-site thoracoscopy	1
On-site access to molecular testing	1
On-site cardiopulmonary exercise testing	1
Total score	11

LCNS, lung clinical nurse specialist; PET, positron emission tomography.

that workforce provision was defined as the total number of programmed activities (PAs) dedicated to lung cancer by that department. In England, PAs are 4 hours of work done within the normal working week. Inconsistencies in results were queried with the trusts.

Organisational score

An organisational score was produced for each lung cancer unit by adding one point for 11 factors from the organisational audit that mapped to the recommendations made in the National Commissioning Guidance (table 1). The guidance recommending access to PET-CT, EBUS and thoracoscopy within 7 days was mapped to each of tests being available on-site. The total score was split into three groups for analysis.

NLCA data

The organisational results were linked to lung cancer unit patient outcomes recorded in the NLCA dataset for the unit where the patient was first seen. The NLCA is a validated database established in 2005, which consists of anonymised records of individuals with a diagnosis of lung cancer. The data for England is collated, maintained and quality assured by the National Cancer Registration and Analysis Service at Public Health England. The data for Wales are collated and quality assured by the Wales Cancer Network (WCN). The NLCA dataset is linked to the following: Hospital Episode Statistics (HES), the National Radiotherapy Dataset (RTDS), the Systemic Anti-Cancer Dataset (SACT) and Office of National Statistics Data. At the time of the survey, the most recently available data from the NLCA included patients diagnosed up to 31 December 2015. Patients were included if they had a diagnosis of lung cancer (International Classification of Diseases code C34). Death certification only diagnoses were excluded.

Covariates

The following variables were identified from the NLCA: sex, age at diagnosis, socioeconomic status (derived from the postcode and linked with the Index of Multiple Deprivation), Eastern Co-operative Oncology Group performance status according to the WHO definition and stage of disease at presentation using TNM version 7.[8] The HES database was used to calculate the Charlson comorbidity preceding the date of lung cancer diagnosis. This score has previously been validated for use in the NLCA.[9]

Outcomes

Three key outcomes were assessed. The first was curative-intent treatment rate, which was defined as the proportion of patients with non-small cell lung cancer (NSCLC) with a record of a curative surgical procedure or received radiotherapy with curative intent (>50 Gy). The second was receipt of active treatment within 62 days. Active treatment was defined as the proportion of patients who had a valid treatment start date for surgery, systemic anticancer therapy or radiotherapy. The third was the proportion of patients alive at 1 year.

Statistical analysis

Data and statistical management was performed by STATA V.14 (StataCorp). Multivariate logistic regression analysis was used to estimate the odds of receiving curative-intent treatment, treatment within 62 days and 1-year survival by the patient and organisational features using a mixed-effects model. Only patient factors known at the time of diagnosis were considered in the final multivariate model to minimise bias. Complete case analysis was performed. Lung cancer units were assigned to one of three groups based on their organisational score. A low score ranged from 0 to4, a medium score from 5 to 7 and a high score from 8 to 11. P values for binary values were based on log-likelihood OR test comparing models with and without the variable. P values for other variables were based on χ^2 value for trends.

RESULTS

Organisational audit scores

The results of the 2017 NLCA organisational audit have been published in detail elsewhere.[1] One hundred and thirty-eight responses to the survey were submitted from 156 trusts (88% participation rate). After removal of duplicate and empty records, 129 records (83%) were available for analysis. Table 2 shows the number of lung cancer units that met each of the individual recommendations included in the score. There was a wide range

Table 2 Number of hospitals that met the recommendations included in the organisational score from the second organisational audit (n=129)

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

LCNS, lung clinical nurse specialist; PET, positron emission tomography.

Table 3 Patient demographics

	Patients (n)	%
Sex		
Female	15 516	46.6
Male	17 796	53.4
Age (years)		
<65	7329	22.0
65–80	18 165	54.5
>80	7818	23.5
Stage		
IA	3359	10.1
IB	2233	6.7
IIA	1269	3.81
IIB	1178	3.54
IIIA	3812	11.4
IIIB	3019	9.06
IV	16 778	50.3
Missing	1664	5.0
Performance status		
0	4816	14.5
1	8681	26.1
2	5373	16.1
3	4877	14.6
4	1613	4.8
Missing	7952	23.9
Townsend quintile		
1 (most affluent)	4534	13.6
2	5968	17.9
3	6787	20.4
4	7520	22.6
5 (least affluent)	8431	25.3
Missing	72	0.2
Charlson index		
0	10 715	32.2
1	5405	16.2
2	5397	16.2
3+	11 795	35.4

of compliance with the recommendations, from only 24 (19%) units meeting the recommendation of one whole time equivalent lung cancer nurse specialist per 80 new diagnoses per year, to 107 (83%) units reporting a radiologist with a third of their job plan devoted to lung cancer. The overall organisational audit score varied by the hospital from 0 to 11. Thirty-eight (29%) units had a score of 0–4, 64 (50%) units had a score of 5–7 and 27 (21%) units had a score of 8–11.

NLCA patients

The NLCA identified 37 769 patients who were diagnosed with lung cancer between 1 January 2015 and 31 December 2015. A total of 4457 patients were excluded as they were first seen at hospitals who did not participate in the organisational audit. A total of 33 312 patients were included in the final analysis. The patient demographic details for the study cohort are shown in table 3. Altogether 7433 patients (25.0%) received treatment with curative intent, 16 773 (50.4%) patients received treatment with 62 days of diagnosis and 11 547 (34.7%) patients were alive at 1 year from diagnosis.

Linkage of the organisational audit with NLCA patient results

The results of the multivariate logistic regression analyses of patient factors and organisational score on patient outcomes are shown in table 4. The results demonstrate that compared with an organisational score of 0–4, patients seen at hospitals with a score of 8–11 had a higher 1-year survival (adjusted OR (95% CI)=2.30 (1.04 to 5.08), p<0.001), higher curative-intent treatment rate (adjusted OR (95% CI)=1.62 (1.26 to 2.09), p<0.001) and greater likelihood of receiving treatment within 62 days (adjusted OR (95% CI)=1.49 (1.20 to 1.86), p<0.001).

DISCUSSION

These data provide an important overview of lung cancer services in England and Wales. We show that there remains inequality in the provision of services and staff. We go further to demonstrate that the provision of resources and organisation of care is associated with patient outcomes through the novel use of an organisational score.

The organisational audit results as assessed against recent lung cancer commissioning guidance demonstrate significant inequity in staff workload. This has previously been highlighted as a key issue,[2] and our results show that this variability still exists, with only 18% of trusts meeting the recommendation that there should be on whole time equivalent lung CNS per 80 new lung cancer diagnoses per year. The audit results also demonstrate significant opportunity to improve the lung cancer diagnostic and treatment pathway, in particular, more widespread implementation of separate diagnostic and treatment planning meetings. This allows proactive testing strategies while reserving the main MDT meeting for high-quality discussion and agreement of treatment plans.

We developed a novel organisational score to assess the relationship between the organisation of a lung cancer service and the outcomes for patients who are seen at that service. Several scores exist that investigate the impact of patient factors on outcome. However, there are few validated scores that examine organisational factors within a healthcare unit on outcomes despite previous studies demonstrating that the interplay of several organisational factors is likely to achieve better patient outcomes rather than an isolated factor.[10–12] The authors of such studies suggest organisational scores are likely to be a reliable way of comparing units. Our organisational score is a composite score based on the recommendations made by the national commissioning guidance for lung cancer.[7] These guidelines are primarily based on clinical opinion and relatively little has been published on how these standards affect patient care. We provide evidence that adherence to this guidance directly impacts patient outcomes.

The previous interrogation of the NLCA dataset demonstrated increased odds of having surgery if a patient is first seen in a surgical centre.[3] Additionally, Lau *et al* demonstrated that increasing the number of thoracic surgeons was associated with an increased resection rate.[13] To our knowledge, this study is first to demonstrate that a bundle of organisational factors is significantly associated with improved patient outcomes (1-year survival, receiving curative-intent treatment and treatment within 62 days). This should come as no surprise given that patients with lung cancer patients are often multimorbid, requiring multiple investigations and combinations of treatments. The

Table 4 Results of multivariate logistic regression analyses using a mixed-effects model investigating the influence of patient factors and organisational score on studied outcomes

	One-year survival (n=33 312)		Treatment within 62 days (n=33 312)		Curative-intent treatment (n=29 793)	
	Adjusted OR (95% CI)	P value for χ^2	Adjusted OR (95% CI)	P value for χ^2	Adjusted OR (95% CI)	P value for χ^2
Sex						
Female	1.00		1.00		1.00	
Male	0.71 (0.70 to 0.75)	<0.001	0.97 (0.93 to 1.03)	0.378	0.91 (0.84 to 0.98)	0.016
Age (years)						
<65	1.00		1.00		1.00	
65–80	0.76 (0.71 to 0.82)		0.60 (0.56 to 0.64)		0.77 (0.70 to 0.85)	
>80	0.45 (0.41 to 0.50)	<0.001	0.18 (0.16 to 0.19)	<0.001	0.22 (0.19 to 0.25)	<0.001
Stage						
IA	1.00		1.00		1.00	
IB	0.65 (0.56 to 0.76)		1.03 (0.91 to 1.17)		0.96 (0.83 to 1.10)	
IIA	0.41 (0.35 to 0.49)		1.05 (0.91 to 1.23)		0.69 (0.58 to 0.82)	
IIB	0.31 (0.26 to 0.36)		1.02 (0.87 to 1.19)		0.50 (0.43 to 0.60)	
IIIA	0.17 (0.15 to 0.20)		1.10 (0.98 to 1.22)		0.19 (0.17 (0.21)	
IIIB	0.08 (0.07 to 0.10)		1.42 (1.26 to 1.60)		0.04 (0.33 to 0.05)	
IV	0.04 (0.03 to 0.04)	<0.001	0.84 (0.77 to 0.92)	<0.001	0.01 (0.01 to 0.01)	<0.001
Performance status						
0	1.00		1.00		1.00	
1	0.60 (0.55 to 0.66)		0.66 (0.60 to 0.72)		0.54 (0.48 to 0.60)	
2	0.30 (0.27 to 0.34)		0.31 (0.28 to 0.34)		0.20 (0.17 to 0.22)	
3	0.12 (0.10 to 0.13)		0.09 (0.08 to 0.10)		0.03 (0.03 to 0.04)	
4	0.05 (0.04 to 0.06)	<0.001	0.03 (0.03 to 0.04)	<0.001	0.09 (0.00 to 0.02)	<0.001
Townsend quintile						
1 (most affluent)	1.00		1.00		1.00	
2	0.87 (0.79 to 0.97)		0.91 (0.83 to 0.99)		1.02 (0.88 to 1.17)	
3	0.94 (0.85 to 1.05)		0.85 (0.77 to 0.93)		0.93 (0.81 to 1.07)	
4	0.88 (0.80 to 0.98)		0.82 (0.75 to 0.90)		0.96 (0.84 to 1.12)	
5 (least affluent)	0.82 (0.74 to 0.90)	0.060	0.75 (0.68 to 0.82)	<0.001	0.87 (0.75 to 1.00)	0.614
Charlson Index						
0	1.00		1.00		1.00	
1	0.94 (0.86 to 1.02)		1.28 (1.18 to 1.39)		1.15 (1.40 to 1.73)	
2	0.85 (0.77 to 0.92)		1.10 (1.02 to 1.20)		1.32 (1.18 to 1.50)	
3+	0.62 (0.58 to 0.67)	0.061	1.14 (1.07 to 1.22)	<0.001	1.07 (0.96 to 1.20)	<0.001
Organisational score						
0–4	1.00		1.00		1.00	
5–7	1.89 (0.99 to 3.61)		1.14 (0.95 to 1.37)		1.13 (0.92 to 1.40)	
8–11	2.30 (1.04 to 5.08)	<0.001	1.49 (1.20 to 1.86)	<0.001	1.62 (1.26 to 2.09)	<0.001

OR adjusted for all variables in the table. The p value for χ^2 is adjusted for trends.

challenge for lung cancer services in the UK is to deliver rapid access for all patients to these resources while ensuring that each treatment centre treats a sufficient volume of patients to maintain performance and cost-effectiveness. In addition, it has been demonstrated that speedier lung cancer pathways are associated with better patient outcomes and several guidelines establish standards for timely care for patients.[14] National UK targets stipulate that patients should receive treatment within 62 days. It is intuitive that ready access to key resources within an increasingly complex patient pathway would result in a faster pathway and our results appear to confirm that this is the case.

Strengths and limitations

The main strength of the study is the completeness and quality of the NLCA dataset. This now includes the linked RTDS and SACT dataset which provides an accurate and detailed picture of lung cancer treatment and management in England. In addition, participation in the organisational audit was high, with the quality of responses enhanced by the provision of help notes and a help desk. That said, we acknowledge that the survey results are not externally validated so may be subject to recall bias. This is particularly relevant to the reporting of staff numbers, which

has been reported in previous studies.[15] An additional limitation is the retrospective nature of the linkage analysis which may be subject to confounding and selection bias despite adjustment for patient factors. However, we believe that the high participation rate and findings which are in keeping with previous work means that the effects of bias are likely to be minimal and therefore the results are generalisable to the UK population.

Summary

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

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