



O'Dowd, Emma L. and McKeever, Tricia M. and Baldwin, David R. and Hubbard, Richard B. (2016) Place of death in patients with lung cancer: a retrospective cohort study from 2004-2013. PLoS ONE, 11 (8). e0161399/1-e0161399/15. ISSN 1932-6203

Access from the University of Nottingham repository:

<http://eprints.nottingham.ac.uk/42883/1/O%27dowd%202016%20PlosOne.pdf>

Copyright and reuse:

The Nottingham ePrints service makes this work by researchers of the University of Nottingham available open access under the following conditions.

This article is made available under the Creative Commons Attribution licence and may be reused according to the conditions of the licence. For more details see: <http://creativecommons.org/licenses/by/2.5/>

A note on versions:

The version presented here may differ from the published version or from the version of record. If you wish to cite this item you are advised to consult the publisher's version. Please see the repository url above for details on accessing the published version and note that access may require a subscription.

For more information, please contact eprints@nottingham.ac.uk

RESEARCH ARTICLE

Place of Death in Patients with Lung Cancer: A Retrospective Cohort Study from 2004-2013

Emma L. O'Dowd^{1*}, Tricia M. McKeever¹, David R. Baldwin², Richard B. Hubbard¹

1 Division of Public Health and Epidemiology, Clinical Sciences Building, Nottingham City Campus, Hucknall Road, Nottingham, United Kingdom, **2** Department of Respiratory Medicine, David Evans Building, Nottingham City Hospital, Hucknall Road, Nottingham, United Kingdom

* emma.o'dowd@nottingham.ac.uk



Abstract

Introduction

Many patients with cancer die in an acute hospital bed, which has been frequently identified as the least preferred location, with psychological and financial implications. This study looks at place and cause of death in patients with lung cancer and identifies which factors are associated with dying in an acute hospital bed versus at home.

Methods and Findings

We used the National Lung Cancer Audit linked to Hospital Episode Statistics and Office for National Statistics data to determine cause and place of death in those with lung cancer; both overall and by cancer Network. We used multivariate logistic regression to compare features of those who died in an acute hospital versus those who died at home.

Results

Of 143627 patients identified 40% (57678) died in an acute hospital, 29% (41957) died at home and 17% (24108) died in a hospice. Individual factors associated with death in an acute hospital bed compared to home were male sex, increasing age, poor performance status, social deprivation and diagnosis via an emergency route. There was marked variation between cancer Networks in place of death. The proportion of patients dying in an acute hospital ranged from 28% to 48%, with variation most notable in provision of hospice care (9% versus 33%). Cause of death in the majority was lung cancer (86%), with other malignancies, chronic obstructive pulmonary disease (COPD) and ischaemic heart disease (IHD) comprising 9% collectively.

Conclusions

A substantial proportion of patients with lung cancer die in acute hospital beds and this is more likely with increasing age, male sex, social deprivation and in those with poor performance status. There is marked variation between Networks, suggesting a need to improve

OPEN ACCESS

Citation: O'Dowd EL, McKeever TM, Baldwin DR, Hubbard RB (2016) Place of Death in Patients with Lung Cancer: A Retrospective Cohort Study from 2004-2013. PLoS ONE 11(8): e0161399. doi:10.1371/journal.pone.0161399

Editor: Yves St-Pierre, Institut national de la recherche scientifique, CANADA

Received: February 10, 2016

Accepted: August 4, 2016

Published: August 23, 2016

Copyright: © 2016 O'Dowd et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: All relevant data are within the paper. The raw data extract is subject to a data sharing agreement between the authors and the Health and Social Care Information Centre and under these terms may not be made publicly available.

Funding: This work was supported by the Roy Castle Lung Cancer Foundation, grant number RB08F1. The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: Dr. Baldwin reports grants from Roche, Irwin Mitchel, Boeringher Ingelheim,

Agfa outside the submitted work; there are no other relationships or activities that could appear to have influenced the submitted work. This does not alter our adherence to PLOS ONE policies on sharing data and materials.

end-of-life planning in those at greatest risk, and to review the allocation of resources to provide more hospice beds, enhanced community support and ensure equal access.

Introduction

Many patients with cancer die in an acute hospital bed although this may be the location they prefer the least.[1] Those who die in acute hospital beds have been shown to have a worse quality of life compared to those who die in hospices or at home.[2] In addition their caregivers are at increased risk of psychiatric problems after the bereavement.[2,3] There are also cost implications; research has shown that end of life care in hospital costs three times more than that delivered in the community.[4,5] The National Health Service (NHS) implemented the National End of Life Care Programme in 2004 with the aim of allowing more patients to receive end of life care in their preferred location.

Following this, Gao and colleagues looked at changes in place of death for all cancer deaths in England between 1993 and 2010.[6] Their work showed that the proportion of patients dying at home or in hospices in many cancer types has increased but in lung cancer, the biggest cause of cancer death worldwide, this does not seem to be the case.[6] Many patients with lung cancer are diagnosed at an advanced stage; in fact 30% of patients are dead within 90 days of diagnosis, however work suggests that clinicians may leave discussions about end-of-life care too late to allow patients to achieve their preferred place of death. [7,8]

These data suggest that there is a need to look at the lung cancer population in particular to try to understand whether there are any features specific to this cancer type which confers an increased risk of dying in an acute hospital setting. This study aimed to determine place and cause of death in patients with lung cancer; to identify which features are associated with dying in an acute hospital bed versus at home; to assess geographical variation in place of death in England and in addition to identify if time of death following diagnosis impacts on ability to achieve preferred place of death. A greater understanding of these factors may allow clinicians to provide better advanced care planning in those at greatest risk.

Methods

Patient population and data source

The National Lung Cancer Audit (NLCA) is a prospective database that collates information provided by 157 English NHS hospitals on demographic, tumour and treatment for patients with primary lung cancer. It is linked to data from Hospital Episode Statistics (HES), used to derive co-morbidity information from coded inpatient episodes, alongside information regarding any interventions and procedures performed, and Office of National Statistics (ONS) that provides information on date, place and cause of death. Data were provided to the researchers under the terms of a data sharing agreement from the Health and Social Care Information Centre (HSCIC). HES and ONS records were linked by staff at the HSCIC to the NLCA using NHS numbers, with a second check to ensure that dates of birth, post codes and sex match. These data were then pseudonymised to ensure that the researchers did not have access to any identifiable fields.

We identified all patients diagnosed with non-small cell (NSCLC) or small cell lung cancer (SCLC) who were recorded in the NLCA between 1st January 2004 and 31st December 2011 inclusive. Those who did not have a date of death recorded on the final date that ONS records

were updated (March 2013–14 months after the last patient entry into the dataset) were presumed to still be alive and therefore excluded from further analysis.

Covariate descriptions

Comorbidity was classified according to Charlson score, which was derived to predict the ten-year mortality for patients with a list of 19 co-morbid conditions. [9]. Clinical coders enter a primary diagnosis or diagnoses and also a list of co-morbidities for each patient episode in HES. ICD-10 codes from linked-HES data were used to identify relevant diagnoses which contribute to the Charlson score. Each condition is assigned a score of 1, 2, 3, or 6, depending on the risk of dying associated with each one and summed to produce a single value for each patient. As all patients had lung cancer this was not included in the ‘any tumour’ section. Patients were then categorised into five groups based on their Charlson index score (0, 1, 2, 3 and ≥ 4). Townsend Index of deprivation was used as a measure of socioeconomic status. This is a post-code derived variable which uses 4 markers of social deprivation derived from census records to categorise patients into quintiles; where 5 is the most deprived and 1 the most affluent grouping. [10] Pre-treatment records in NLCA were used for stage (grouped as IA/IB, IIA/IIB, IIIA, IIIB, IV, SCLC limited or SCLC extensive) according to the 7th edition of UICC TNM, with post-treatment stage used if pre-treatment records were missing. We used pre-treatment recording of histology and again post-treatment records were used if this was missing. The NLCA uses the Eastern Cooperative Oncology Group (ECOG) definition of performance status (PS). This is a subjective marker which is used to try to quantify general well-being and ability to carry out activities of daily life and ranges from 0–5, where 0 is fully active, able to carry on all pre-disease performance without restriction and 4 is completely disabled; cannot carry on any self-care; totally confined to bed or chair (5 is dead).” [11] We used age at the time of diagnosis to categorise patients into eight groups (<55, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84 and ≥ 85 years). NLCA records were used to identify source of referral. This refers to the source of referral to the lung cancer team and comprises two emergency routes (following an emergency admission or following an accident and emergency (A&E) attendance) and seven semi-elective routes which include GP referral and referral from another secondary care provider or allied health professional.

ONS records were used to characterise place of death as home, acute hospital, residential/nursing home, hospice, community/rehabilitation hospital or elsewhere. Cause of death was defined by ONS using the criteria set out in the 10th revision of the “International classification of diseases” (ICD-10) to determine a single underlying cause of death. [12] England was divided into 28 cancer networks at the time this data was collected so we used these to assess geographical variation in place of death. We calculated the proportion of patients dying in each location and stratified this by cancer network. We also aimed to look at changes in place of death over the duration of the NLCA. We created four groups based on year of death (2004–2006, 2007–2008, 2009–2010 and 2011–2013) and looked at the proportion of patients dying in each place, as described previously, for each year grouping. Work from the Routes From Diagnosis project showed that 50% of lung cancer patients died within 6 months of diagnosis. [13] To try to identify if there was a difference in place of death related to time from diagnosis we identified those who died within 6 months of diagnosis and compared the proportion dying in each location with those who died more than 6 months after diagnosis.

Statistical methods

All statistical analyses were conducted using Stata MP V.12 (StataCorp, Texas, USA). In order to compare the factors influencing death in the least preferred location (acute hospital) with

home, which is frequently reported to be the desired place of death, we excluded those who died in other locations from this part of the analysis. Given the median age of diagnosis for lung cancer is 72 years in the UK we used this as our reference category rather than the youngest age grouping for analysis. Logistic regression was used to calculate odds ratios (OR) for death within an acute hospital bed within each of the variables described above. We looked at each variable individually initially, then included those which showed an association in the univariate model ($p < 0.05$) in the multivariate analysis. Likelihood ratio testing (LRT) was used for all tests of significance. We conducted a sensitivity analysis, excluding those with missing data, to ensure that our findings were robust. There was minimal change in odds ratios and 95% confidence intervals, so the results of the original multivariate analysis including all patients are presented in the results section.

The Healthcare Quality Improvement Partnership (HQIP) approved the use of the National Lung Cancer Audit for this work. This study does not involve identifiable human participants—an anonymized dataset was obtained via the HSCIC (under the terms of a data sharing agreement (reference RU943-R1)) who hold data extracted and anonymised specifically for research use. No study authors had any role in data collection and no personal patient information was provided in the data which was obtained by the authors. Analysis of these data were reviewed and approved by the University of Nottingham research ethics committee in December 2012 (reference B15112012LT CHS EPH).

Results

Patient population and data source

Records were identified for 178,178 patients in the NLCA. Of these 24150 were excluded as they were still alive at the time ONS records were last accessed for dates of death and a further 8702 patients with carcinoid or mesothelioma histological subtypes, 1417 with dates of diagnosis after their date of death and 282 with missing information on place of death were also excluded. This left a final cohort of 143,627 patients.

Demographic features

Overall 58% were male, with a median age at diagnosis of 73 years (interquartile range (IQR) 65–79 years). The majority had NSCLC (88%) and most patients had advanced disease at presentation; 39% had stage IV NSCLC, 12% stage IIIB, with stages IA to IIA NSCLC comprising 18% collectively. A large proportion of patients were from the most deprived socioeconomic groups (40% from Townsend quintiles 4 and 5), with a median Charlson co-morbidity score of 1 (IQR 0–3). Median survival from the time of diagnosis was 145 days (IQR 47–346 days).

Place of death

Forty per cent of patients (57678) died in acute hospital beds, 29% (41957) in their own home, 17% (24108) in hospice beds, 8% (12099) died in residential or nursing homes, 4% (5517) in community or rehabilitation hospitals and 2% (2268) “elsewhere”; which contained those dying within prisons and mental health institutions. A summary of the demographics of those dying in each location is provided in [Table 1](#). Those dying in residential or nursing homes were older than the other localities and had worse WHO performance status at diagnosis (33% PS 3 or 4). Proportionally more of the younger age groups died within hospices. Those from the most affluent socioeconomic groups (Townsend quintiles 1 and 2) were most likely to die either in a hospice or at home.

Table 1. Demographics of patients stratified by place of death.

	Home	Acute hospital	Residential/nursing home	Hospice	Community/rehab hospital	Elsewhere	Total
	N = 41957	N = 57678	N = 12099	N = 24108	N = 5517	N = 2268	N = 143627
	n	n	n	n	n	n	n
	%	%	%	%	%	%	%
Sex							
Female	17794	22820	5926	10851	2341	1208	60940
Male	24163	34858	6173	13257	3176	1060	82687
Age group							
<55	2593	3562	151	2022	199	173	8700
55-59	3161	4173	300	2103	264	162	10163
60-64	5276	6895	621	3292	470	239	16793
65-69	6570	8780	1013	3802	701	333	21199
70-74	7609	10347	1576	4144	903	357	24936
75-79	7791	10401	2369	4048	1111	394	26114
80-84	5732	8066	2830	2994	1096	360	21078
85+	3225	5454	3239	1703	773	250	14644
Performance status							
0	5513	6874	820	3264	547	255	17273
1	10513	13229	1942	6187	1180	514	33565
2	7512	9446	2099	4084	899	432	24472
3	6341	8625	2910	3148	910	372	22306
4	1451	3657	1128	794	278	81	7389
Missing	10627	15847	3200	6631	1703	614	38622
Charlson score							
0	16627	21170	4158	10121	2164	965	55745
1	8553	12162	2594	4623	1120	466	29518
2	5039	7124	1641	2674	631	253	17362
3	2605	3944	1026	1358	368	120	9421
>4	9133	12738	2680	5332	1234	464	31581
Townsend quintile							
1	6000	7029	1766	3456	748	307	19306
2	7262	8531	2111	4129	1096	376	23505
3	7277	9641	2452	4282	1151	359	25162
4	8002	11175	2400	4362	1031	459	27429
5	8647	13358	2046	4807	606	516	29980
Missing	4769	7944	1324	3072	885	251	18245
Histology							
Adenocarcinoma	6790	9248	1348	4506	748	377	23017
Squamous cell	7313	9433	1615	3772	837	380	23350
NSCLC NOS	7746	10155	1549	4653	993	383	25479
SCLC	5384	6954	928	3037	604	282	17189
Other	1721	2205	444	1055	193	89	5707
Missing	13003	19683	6215	7085	2412	757	48885
Stage							
IA/IB	2325	3904	990	1140	288	110	8757
IIA/IIB	1589	2262	587	820	175	83	5516

(Continued)

Table 1. (Continued)

	Home		Acute hospital		Residential/nursing home		Hospice		Community/rehab hospital		Elsewhere		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
	N = 41957		N = 57678		N = 12099		N = 24108		N = 5517		N = 2268		N = 143627	
IIIA	3351	8	4156	7.2	1020	8.4	1833	7.6	370	6.7	160	7.1	10890	7.6
IIIB	5356	12.8	7013	12.2	1305	10.8	2935	12.2	654	11.9	290	12.8	17553	12.2
IV	16773	40	21605	37.5	4414	36.5	9928	41.2	2036	36.9	920	40.6	55676	38.8
SCLC Limited	448	1.1	536	0.9	75	0.6	225	0.9	48	0.9	14	0.6	1346	0.9
SCLC Extensive	1047	2.5	1502	2.6	152	1.3	635	2.6	149	2.7	58	2.6	3543	2.5
Missing	11068	26.4	16700	29	3556	29.4	6592	27.3	1797	32.6	633	27.9	40346	28.1
Emergency admission	5012	12	9096	15.8	2243	18.5	2708	11.2	951	17.2	308	13.6	20318	14.2
GP referral	21255	50.7	25453	44.1	4809	39.8	11651	48.3	2607	47.3	1018	44.9	66793	46.5
Consultant referral	8092	19.3	11287	19.6	2495	20.6	4719	19.6	928	16.8	456	20.1	27977	19.5
A&E	2514	6	4485	7.8	1077	8.9	1534	6.4	353	6.4	183	8.1	10146	7.1
Other	2787	6.6	4032	7	814	6.7	1807	7.5	283	5.1	186	8.2	9903	6.9
Unknown	2297	5.5	3325	5.8	661	5.5	1695	7	395	7.2	117	5.2	8490	5.9
0–6 months	21574	51.4	35504	61.6	6398	52.9	12105	50.2	3281	59.5	1367	60.3	80229	55.9
> 6 months	20383	48.6	22174	38.4	5701	47.1	12003	49.8	2236	40.5	901	39.7	63398	44.1

doi:10.1371/journal.pone.0161399.t001

Multivariable analysis

In order to compare the odds of death in an acute hospital with home we excluded the 43992 patients who died in the other locations, which left us with a cohort of 99635 patients for the univariable and multivariable analyses. The results are presented in [Table 2](#). Males were more likely than females to die in acute hospital beds compared with home (adjusted odds ratio (OR) 1.14; 95% confidence interval (95% CI) 1.12–1.17). Those in the oldest age bracket (85 years and older) were at increased odds of dying in acute hospital beds (adjusted OR 1.16; 95% CI 1.08–1.24) compared with all of the younger age groups. There was no real difference between the other age brackets and likelihood of death within an acute hospital bed. Patients who presented at WHO performance status 4 (bed bound) were more likely to die in acute hospitals compared with those who were fitter (adjusted OR 1.73; 95% CI 1.61–1.87 for WHO PS 4 compared to WHO PS 0). Again there was only an impact on likelihood of dying with an acute hospital in the least fit group (WHO PS 4), with no difference between the other classes in the multivariable analysis. There were increasing odds of death within acute hospitals with increasing levels of socioeconomic deprivation (adjusted OR 1.31; 95% CI 1.25–1.37) for Townsend quintile 5 versus quintile 1). Compared with diagnosis via a general practitioner (GP) referral via all other routes was associated with an increased chance of dying within an acute hospital bed. This was most marked for the emergency admission route (adjusted OR 1.45; 95% CI 1.39–1.51) and in those diagnosed following attendance at accident and emergency (A&E) departments (adjusted OR 1.43; 95% CI 1.35–1.51). Those with highest stage disease (stage IV) at diagnosis were less likely to die in acute hospital beds when compared with those with earlier stage disease at presentation (adjusted OR 0.74; 95% CI 0.70–0.79). In fact those with stage IA and IB NSCLC were more likely to die in acute hospital beds than all other stages of NSCLC and also than those with limited and extensive stage SCLC.

Geographical variation in place of death

There was evidence of marked variation in place of death when we stratified patients by each of the 28 cancer networks ([Fig 1](#)). These regional inequalities were most marked in the proportion of patients dying within hospices, with only 9% in the lowest network dying within this setting compared with 33% in the highest. There was a 20% difference in the proportion dying in acute hospital beds between the lowest and highest cancer network (28% to 48%). There was similar variation in the proportion of patients dying in their own home (22% versus 34% in the highest and lowest networks respectively).

Changes over time

Changes in place of death between 2004 and 2013 were also assessed ([Fig 2](#)), showing a decrease in the proportion of patients dying in acute hospital beds from 45% in 2004–2006 to 35% in 2011–2013. There has been a corresponding increase in the proportion dying at home (26% in 2004–2006 compared to 32% in 2011–2013) but only a very small increase (from 16% to 18%) in the proportion dying within hospice beds. An increase in those dying within residential and nursing home beds has been mirrored by a reduction in the number of community hospital beds and corresponding decrease in the proportion dying within that setting.

Time from diagnosis to death

Finally we looked at place of death in those who died in the 6 months following the lung cancer diagnosis and compared this with those who survived for more than 6 months. These results are summarised in [Table 3](#). Fifty six per cent of our patients died within the 0–6 month time frame.

Table 2. Results of univariate and multivariate analysis comparing death in an acute hospital versus death at home.

		Univariate analysis			Multivariate analysis		
		Death in acute hospital	95% CI	pvalue (LRT)	Death in acute hospital	95% CI	pvalue (LRT)
		OR	95% CI	(LRT)	OR	95% CI	(LRT)
Sex	Female	1		p<0.01	1		p<0.01
	Male	1.28	1.26–1.31		1.14	1.12–1.17	
Age group	<55	0.96	0.90–1.03		0.97	0.91–1.04	
	55–59	0.95	0.89–1.01		0.97	0.91–1.03	
	60–64	0.97	0.92–1.03		0.98	0.92–1.02	
	65–69	0.99	0.93–1.05		0.98	0.93–1.04	
	70–74	1		p<0.01	1		p<0.01
	75–79	0.97	0.92–1.03		0.95	0.90–1.01	
	80–84	1.02	0.96–1.09		0.99	0.93–1.06	
	85+	1.23	1.15–1.32		1.16	1.08–1.24	
Performance status	0	1		p<0.01	1		p<0.01
	1	1.01	0.97–1.05		0.99	0.95–1.03	
	2	1.01	0.96–1.06		0.95	0.90–0.99	
	3	1.09	1.04–1.14		0.97	0.93–1.03	
	4	2.02	1.88–2.17		1.73	1.61–1.87	
	Missing	1.2	1.15–1.25		1.08	1.03–1.13	
Charlson score	0	1		p<0.01	1		p = 0.251
	1	1.09	1.05–1.13		1.04	1.00–1.08	
	2	1.08	1.04–1.13		1.02	0.98–1.06	
	3	1.16	1.10–1.22		1.06	1.01–1.12	
	≥4	1.07	1.03–1.10		0.99	0.96–1.03	
Townsend quintile	1	1		p<0.01	1		p<0.01
	2	1	0.96–1.05		1.01	0.96–1.06	
	3	1.13	1.08–1.18		1.13	1.08–1.18	
	4	1.19	1.14–1.25		1.19	1.13–1.24	
	5	1.32	1.26–1.38		1.31	1.25–1.37	
	Missing	1.42	1.35–1.49		1.38	1.31–1.46	
Histology	Adenocarcinoma	1		p<0.01	1		p = 0.026
	Squamous cell	0.95	0.91–0.99		0.92	0.88–0.97	
	NSCLC NOS	0.96	0.92–1.00		0.97	0.93–1.01	
	SCLC	0.95	0.90–0.99		0.92	0.88–0.98	
	Other	0.94	0.88–1.01		0.92	0.86–0.99	
	Missing	1.11	1.07–1.15		0.97	0.94–1.01	
Stage	IA/ IB	1		p<0.01	1		p<0.01
	IIA/ IIB	0.85	0.78–0.92		0.86	0.79–0.94	
	IIIA	0.74	0.69–0.79		0.76	0.71–0.82	
	IIIB	0.78	0.73–0.83		0.79	0.74–0.84	
	IV	0.77	0.73–0.81		0.74	0.70–0.79	
	SCLC Limited	0.71	0.62–0.82		0.76	0.66–0.87	
	SCLC Extensive	0.85	0.78–0.94		0.86	0.77–0.95	
	Missing	0.9	0.85–0.95		0.84	0.79–0.89	

(Continued)

Table 2. (Continued)

		Univariate analysis			Multivariate analysis		
		Death in acute hospital		pvalue	Death in acute hospital		pvalue
		OR	95% CI	(LRT)	OR	95% CI	(LRT)
Source of referral	Emergency admission	1.52	1.46–1.58		1.45	1.39–1.51	
	GP referral	1		p<0.01	1		p<0.01
	Consultant referral	1.16	1.13–1.20		1.13	1.09–1.17	
	A&E	1.49	1.41–1.57		1.43	1.35–1.51	
	Other	1.21	1.15–1.27		1.16	1.10–1.23	
	Unknown	1.21	1.14–1.28		1.16	1.09–1.23	

LRT- likelihood ratio test

doi:10.1371/journal.pone.0161399.t002

Proportionally more of these patients died in acute hospital beds (44% compared to 35% of those who lived for over 6 months). Patients who survived for over 6 months after their diagnosis were more likely to die at home (32% versus 27%) or in a hospice setting (19% versus 15%) than those who died in the first 6 month window. Those who died within the initial 6 months after diagnosis were older (median age at diagnosis of 74 years (IQR 66–80) compared with median age at diagnosis of 71 years (IQR 63–78) in the group who lived for longer than 6 months). There were similar proportions of males and females between the 2 groups (58% males in the group who died within 6 months of diagnosis versus 56% in the group who survived for longer). There was a marked difference in the distribution of performance status when comparing the 2 groups; 50% of those in the group who survived more than 6 months were deemed to be WHO PS 0 or 1 at diagnosis compared with only 23% of those in the group who died within 0–6 month time frame. There were proportionally more patients who were felt to be WHO PS 3 or 4 in the cohort who died within 6 months (30% versus 8%). Seventeen per cent of those in the group who lived for longer than 6 months presented with lung cancer that was stage IA–IIB compared with only 5% in the group who died within 6 months, whilst 48% of the group who died within 6 months had stage IV disease at presentation versus 27% in the group who survived for longer. The group who died within 6 months were also proportionally more likely to be diagnosed via an emergency admission route (28% versus 12%), with only 40% referred from their GP compared with 55% in the group who lived for longer than 6 months.

Cause of death

Cause of death was recorded as lung cancer in 86% (123147) of patients. Death was attributed to other malignancies in 6% (8996) of cases, chronic obstructive pulmonary disease (COPD) in 1.4% (2021) and ischaemic heart disease (IHD) in 1.5% (2172), with a variety of other conditions comprising the remaining 5%.

Discussion

Our results show that, although there has been a 10% reduction in the proportion of patients with lung cancer dying in acute hospital beds between 2004 and 2013, 35% still die within that setting. Old age (≥ 85 years), male sex, socioeconomic deprivation, WHO performance status

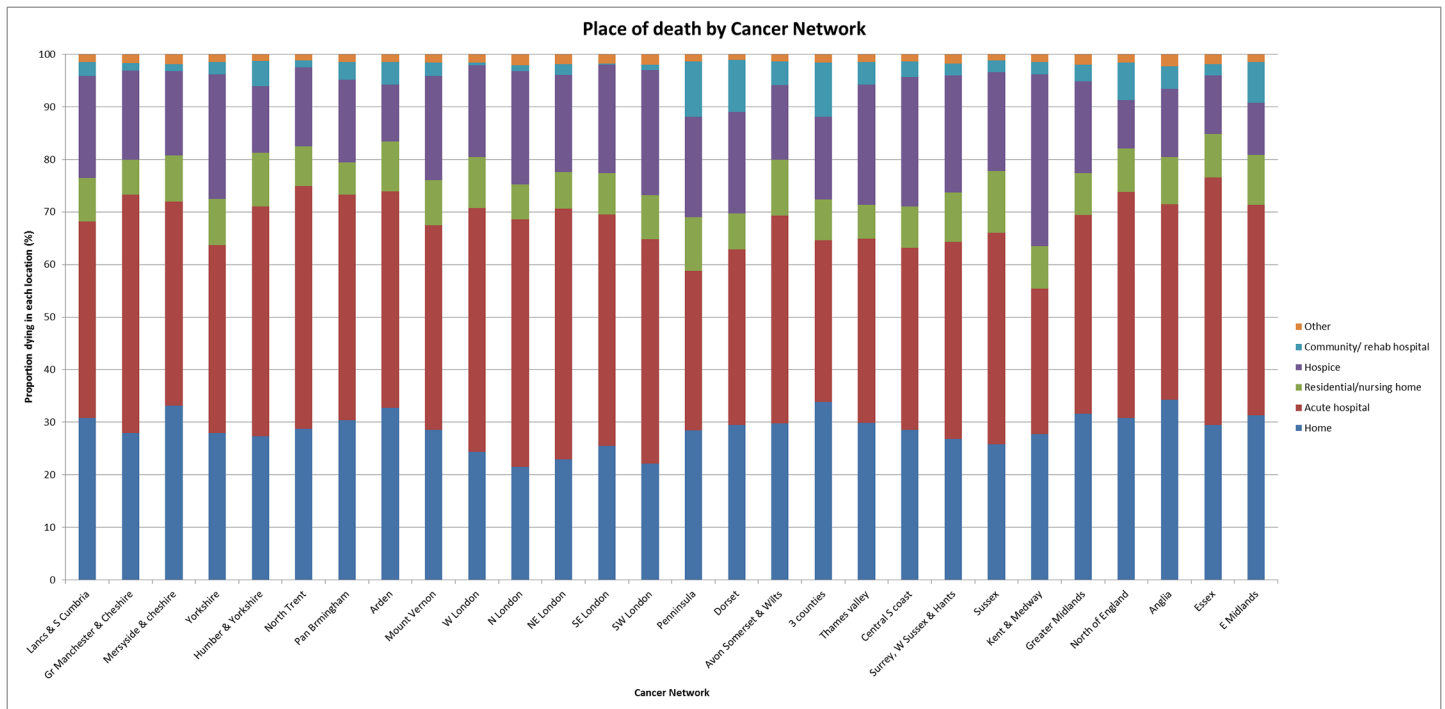


Fig 1. Place of death stratified by cancer Network.

doi:10.1371/journal.pone.0161399.g001

4 at diagnosis and emergency route to diagnosis are all strongly and independently associated with increased likelihood of death within acute hospitals, although death in this location is less likely with more advanced stage disease at presentation. In addition there is evidence of geographical variation in place of death, particularly with regard to provision of hospice services.

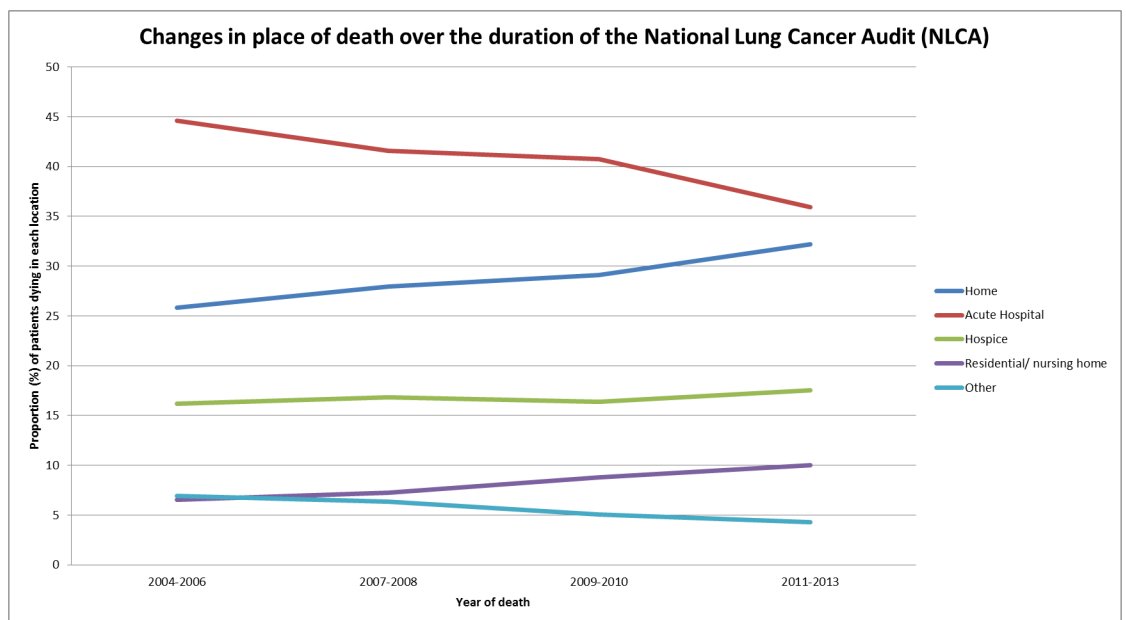


Fig 2. Changes in place of death between 2004 and 2013.

doi:10.1371/journal.pone.0161399.g002

Table 3. Demographic features of patients comparing those who died within 0–6 months following diagnosis and > 6 months.

		Death within 0–6 months of diagnosis		Death > 6 months after diagnosis	
		N = 80229	%	N = 63398	%
Place of death	Home	21574	27	20383	32
	Acute hospital	35504	44	22174	35
	Residential/ nursing home	6398	8	5701	9
	Hospice	12105	15	12003	19
	Community/ rehab hospital	3281	4	2236	4
	Elsewhere	1367	2	901	1
Sex	Female	33333	42	27607	44
	Male	46896	58	35791	56
Median age at diagnosis	Years (IQR)	74 (66–80)		71 (63–78)	
Performance status	0	5110	6	12163	19
	1	13858	17	19707	31
	2	15054	19	9418	15
	3	17578	22	4728	7
	4	6731	8	658	1
	Missing	21898	27	16724	26
Stage	IA/ IB	2061	3	6807	11
	IIA/ IIB	1713	2	3803	6
	IIIA	4030	5	6860	11
	IIIB	8439	11	9114	14
	IV	38540	48	17136	27
	SCLC Limited	378	0.5	968	2
	SCLC Extensive	2148	3	1395	2
	Missing	22920	29	17315	27
	Source of referral	Emergency admission	15269	19	5049
GP referral		31763	40	35030	55
Consultant referral		15760	20	12217	19
A&E		7476	9	2670	4
Other		5260	7	4643	7
Unknown		4701	6	3789	6

doi:10.1371/journal.pone.0161399.t003

Given the often advanced stage of disease at presentation and poor prognosis it is unsurprising that the majority of patients with a diagnosis of lung cancer are recorded as having died of the underlying disease.

Strengths and limitations

This is one of the first studies to look in detail at both place and cause of death in lung cancer patients specifically and the large number of patients and representative nature of the population is a particular strength. The NLCA has previously been validated as a reliable source of the UK lung cancer data and currently has in excess of 90% case ascertainment. [14] Although data completeness is improving in the NLCA, missing data are still a challenge. A sensitivity

analysis conducted excluding those with missing data fields did not change any of the results substantially suggesting that the missing data did not affect the validity of our findings. The population in NLCA is predominantly white which does make extrapolation of these results to other ethnic groupings difficult. In addition work by Gao et al [6] has suggested that marital status may be relevant to place of death; with those who are single, widowed or divorced being more likely to die in the hospital setting. These data are not routinely recorded in our datasets so there may be confounding due to inability to adjust for this. We were also unable to take into account patient preference in place of death or assess whether this might change when faced with worsening symptoms in the terminal phase of the illness. However, although we accept that not all patients will choose to die at home existing evidence suggests that this is the preference for most. [1]

Other work in the literature

Gao and colleagues used ONS data to look at changes in place of death for all cancer deaths in England between 1993 and 2010. [6] They also looked at some features associated with death at home or in a hospice. Although there was a decrease in the overall proportion of cancer patients dying in hospital over this time frame there was little change in the lung cancer group. Similar to our study they found that male sex, increasing age, social deprivation and in addition marital status were independently associated with increased likelihood of dying in acute hospitals. A further piece of work by Gomes et al [15] looked at changes in place of death between 2004 and 2010 for both cancer and non-cancer patients and showed that there has been a small rise in the proportion of patients overall dying at home over this time period; with 27% of all cancer patients dying in their own home in 2010. This is very similar to the 29% we observed in the lung cancer population for the years 2009–2010. In addition Davies et al [16] assessed changes in place of death for cancer patients in the Thames Cancer Registry over a 17 year period (1985–2002), showing a decrease in the proportion of patients dying within acute hospital beds from 67% to 47% by 2002. They also showed that those who were older (> 75 years) were more likely to die in acute hospital beds. A randomised controlled trial conducted by Brumley et al [17] assigned patients with a terminal prognosis to usual care or in-home palliative care, which comprised not only pain and symptom relief, but a variety of educational, medical and social support services. They looked at visits to the emergency department (ED) and also place of death in both groups and showed that the group receiving palliative care support had fewer visits to the ED and also were 20% more likely to die at home compared to the usual care arm. This highlights the key role that early and effective palliative care has to play in ensuring that wherever possible patients are able to achieve their preferred place of death. Studies consistently show that patients with lung cancer are more likely to die in acute hospital beds than patients with many other solid organ tumours and there is a suggestion that this is due to late discussions about end-of-life care [7] in combination with a rapidly progressive disease. A study looking at hospitalisations towards the end of life specifically in poor-prognosis cancer types in the United States showed that high-intensity inpatient care (including administration of chemotherapy and admission to Intensive care units) was delivered close to death in many patients, which may prevent better supportive care being delivered and end-of-life decisions being made in a timely manner. [18] There is evidence that patients who discuss end of life care preferences are more likely to die within home or hospice settings however we did not have the data available to know what extent these factors contributed to death within acute hospital settings in our cohort. [19,20] It may be that those patients who survived for more than 6 months after diagnosis had more time to plan and discuss preferences for end of life care than those who died earlier in the disease process possibly explaining in part the smaller proportion of

patients in this group who died in acute hospital beds when compared with those who died in the 6 months immediately following their diagnosis. A variety of patient and tumour features also contribute to mortality within the initial 6 months following diagnosis which may make discharge from acute hospital beds more difficult to facilitate. Work from the National Cancer Intelligence Network (NCIN) “Routes to Diagnosis” project has shown that lung cancer patients who present via the emergency route have a much lower 1 year survival [21] which explains why proportionally more patients in the group who died within 0–6 months were diagnosed via an emergency admission route. In addition performance status has been previously shown to be an independent predictor for overall survival in lung cancer, with the differences in performance status marked between those who died within 6 months and those who lived for longer in our cohort.[22]

Work performed in South East England has suggested that those from ethnic minority groups were more likely to die in hospital beds and less likely to access hospice services than white patients, which suggests there may be an additional need to look in more detail at the ethnicity of patients and the part it has to play in place of death.[23] The wide geographic variations in place of death are likely to represent service availability and accessibility. A study by Gatrell et al [24] looked at variations in geographic access to hospices in England and Wales and showed that there are inequities in provision of beds between regions, with the lowest numbers of beds per 1000 cancer deaths in the North East and East Midlands; which corresponds to the two cancer Networks with the lowest proportion of patients dying within hospice beds in our study (North of England and East Midlands). Furthermore a piece of work from Sleeman et al [25] suggested that those from a more affluent background were more likely to die in a hospice setting than those from the most deprived socio-economic grouping, suggesting that inequities in access are not only geographic.

Interpretation of the results

The fact that those with higher stage disease at presentation are less likely to die within an acute hospital setting was an unexpected finding, however it may indicate that we are better at offering early palliative care to patients with non-curative disease to try to ensure that they achieve their preference in place of death compared with those who undergo surgery or aggressive systemic anti-cancer treatment; where the focus is on management with curative intent rather than end of life care. Those with higher stage disease would also therefore be less likely to suffer morbidity and mortality related to treatment side effects which may necessitate hospitalisation in the latter days of life. It may also be the case that recognition that the patient has reached the terminal phase of the disease, with a shift in the treatment paradigm from curative to palliative, may occur too late to allow the preference in place of death to be met. There is no study which has specifically addressed this question however. It is difficult to suggest what the optimal proportion of patients dying in acute hospital settings should be as many patients develop distressing symptoms in the latter days of life which necessitate hospitalisation. Only 28% of patients in the lowest cancer network died in acute hospital beds (due principally to a large number of in-hospice deaths in this region) so it is not unreasonable to suggest that this could be the gold standard given optimal service provision and resource allocation, although we recognise that there are differing social and patient demographic features which also may influence this between regions. Another option may be to optimise palliative services for these patients on site at acute hospitals or provide a more integrated community and acute hospital service than many regions currently have to facilitate discharge to a more appropriate setting.

Clinical relevance and conclusions

A substantial proportion of patients with lung cancer die in acute hospital beds and this is more likely in the most elderly (≥ 85 years), males, those who are socially deprived, those diagnosed via an emergency admission route and in those with the worst performance status (WHO PS 4). There is marked geographical variation, suggesting a need to improve end-of-life planning in those at greatest risk, and to review the allocation of resources to provide more hospice beds, enhanced community support and ensure equal access. Increasing the proportion of patients dying in the community would undoubtedly offer cost savings in addition to psychological benefits.

Author Contributions

Conceived and designed the experiments: EOD TMM DRB RBH.

Analyzed the data: EOD DRB TMM RBH.

Wrote the paper: EOD TMM DRB RBH.

References

1. Gomes B, Higginson IJ, Calanzani N, Cohen J, Deliens L, et al. (2012) Preferences for place of death if faced with advanced cancer: a population survey in England, Flanders, Germany, Italy, the Netherlands, Portugal and Spain. *Annals of Oncology* 23: 2006–2015. PMID: [22345118](#)
2. Wright AA, Keating NL, Balboni TA, Matulonis UA, Block SD, et al. (2010) Place of Death: Correlations With Quality of Life of Patients With Cancer and Predictors of Bereaved Caregivers' Mental Health. *Journal of Clinical Oncology* 28: 4457–4464. doi: [10.1200/JCO.2009.26.3863](#) PMID: [20837950](#)
3. Mitchell AJ, Chan M, Bhatti H, Halton M, Grassi L, et al. (2011) Prevalence of depression, anxiety, and adjustment disorder in oncological, haematological, and palliative-care settings: a meta-analysis of 94 interview-based studies. *Lancet Oncology* 12: 160–174. doi: [10.1016/S1470-2045\(11\)70002-X](#) PMID: [21251875](#)
4. Jordhoy MS, Fayers P, Saltnes T, Ahlner-Elmqvist M, Jannert M, et al. (2000) A palliative-care intervention and death at home: a cluster randomised trial. *Lancet* 356: 888–893. PMID: [11036893](#)
5. Marie Curie Cancer Care (2012) Understanding the cost of end of life care in different settings. London.
6. Gao W, Ho YK, Verne J, Glickman M, Higginson IJ, et al. (2013) Changing Patterns in Place of Cancer Death in England: A Population-Based Study. *Plos Medicine* 10.
7. Mack JW, Cronin A, Taback N, Huskamp HA, Keating NL, et al. (2012) End-of-Life Care Discussions Among Patients With Advanced Cancer A Cohort Study. *Annals of Internal Medicine* 156: 204–U265. doi: [10.7326/0003-4819-156-3-201202070-00008](#) PMID: [22312140](#)
8. O'Dowd E, McKeever T, Powell HA, Anwar S, Baldwin D, et al. (2014) Predictors of early death from lung cancer in primary care. *Lung Cancer* 83: S34–S35.
9. Charlson ME, Pompei P, Ales KL, Mackenzie CR (1987) A NEW METHOD OF CLASSIFYING PROGNOSTIC CO-MORBIDITY IN LONGITUDINAL-STUDIES—DEVELOPMENT AND VALIDATION. *Journal of Chronic Diseases* 40: 373–383. PMID: [3558716](#)
10. Townsend P, Phillimore P, Beattie A (1988) Health and Deprivation: Inequality and the North: Croom Helm.
11. Oken MM, Creech RH, Tormey DC, Horton J, Davis TE, et al. (1982) TOXICITY AND RESPONSE CRITERIA OF THE EASTERN-COOPERATIVE-ONCOLOGY-GROUP. *American Journal of Clinical Oncology-Cancer Clinical Trials* 5: 649–655.
12. World Health Organisation (2010) International statistical classification of diseases and related health problems, 10th revision, Vol.2: Instruction manual. Geneva.
13. Macmillan Cancer Support (2014) Cancer's unequal burden—The reality behind improving cancer survival rates.
14. Rich AL, Tata LJ, Stanley RA, Free CM, Peake MD, et al. (2011) Lung cancer in England: Information from the National Lung Cancer Audit (LUCADA). *Lung Cancer* 72: 16–22. doi: [10.1016/j.lungcan.2010.07.002](#) PMID: [20688413](#)

15. Gomes B, Calanzani N, Higginson IJ (2012) Reversal of the British trends in place of death: Time series analysis 2004–2010. *Palliative Medicine* 26: 102–107. doi: [10.1177/0269216311432329](https://doi.org/10.1177/0269216311432329) PMID: [22258367](https://pubmed.ncbi.nlm.nih.gov/22258367/)
16. Davies E, Linklater KM, Jack RH, Clark L, Moller H (2006) How is place of death from cancer changing and what affects it? Analysis of cancer registration and service data. *British Journal of Cancer* 95: 593–600. PMID: [16909139](https://pubmed.ncbi.nlm.nih.gov/16909139/)
17. Brumley R, Enguidanos S, Jamison P, Seitz R, Morgenstern N, et al. (2007) Increased satisfaction with care and lower costs: Results of a randomized trial of in-home palliative care. *Journal of the American Geriatrics Society* 55: 993–1000. PMID: [17608870](https://pubmed.ncbi.nlm.nih.gov/17608870/)
18. Morden NE, Chang C-H, Jacobson JO, Berke EM, Bynum JPW, et al. (2012) End-Of-Life Care For Medicare Beneficiaries With Cancer Is Highly Intensive Overall And Varies Widely. *Health Affairs* 31: 786–796. doi: [10.1377/hlthaff.2011.0650](https://doi.org/10.1377/hlthaff.2011.0650) PMID: [22492896](https://pubmed.ncbi.nlm.nih.gov/22492896/)
19. Wright AA, Zhang B, Ray A, Mack JW, Trice E, et al. (2008) Associations between end-of-life discussions, patient mental health, medical care near death, and caregiver bereavement adjustment. *Jama—Journal of the American Medical Association* 300: 1665–1673.
20. Prigerson HG (1991) Determinants of hospice utilization among terminally ill geriatric patients. *Home health care services quarterly* 12: 81–112. PMID: [10117496](https://pubmed.ncbi.nlm.nih.gov/10117496/)
21. Elliss-Brookes L, McPhail S, Ives A, Greenslade M, Shelton J, et al. (2012) Routes to diagnosis for cancer—determining the patient journey using multiple routine data sets. *British Journal of Cancer* 107: 1220–1226. doi: [10.1038/bjc.2012.408](https://doi.org/10.1038/bjc.2012.408) PMID: [22996611](https://pubmed.ncbi.nlm.nih.gov/22996611/)
22. Kawaguchi T, Takada M, Kubo A, Matsumura A, Fukai S, et al. (2010) Performance Status and Smoking Status Are Independent Favorable Prognostic Factors for Survival in Non-small Cell Lung Cancer A Comprehensive Analysis of 26,957 Patients with NSCLC. *Journal of Thoracic Oncology* 5: 620–630. doi: [10.1097/JTO.0b013e3181d2dcd9](https://doi.org/10.1097/JTO.0b013e3181d2dcd9) PMID: [20354456](https://pubmed.ncbi.nlm.nih.gov/20354456/)
23. Coupland VH, Madden P, Jack RH, Moller H, Davies EA (2011) Does place of death from cancer vary between ethnic groups in South East England? *Palliative Medicine* 25: 314–322. doi: [10.1177/0269216310395986](https://doi.org/10.1177/0269216310395986) PMID: [21248180](https://pubmed.ncbi.nlm.nih.gov/21248180/)
24. Gatrell AC, Wood DJ (2012) Variation in geographic access to specialist inpatient hospices in England and Wales. *Health & Place* 18: 832–840.
25. Sleeman KE, Davies JM, Verne J, Gao W, Higginson IJ (2016) The changing demographics of inpatient hospice death: Population-based cross-sectional study in England, 1993–2012. *Palliative Medicine* 30: 45–53. doi: [10.1177/0269216315585064](https://doi.org/10.1177/0269216315585064) PMID: [25991729](https://pubmed.ncbi.nlm.nih.gov/25991729/)