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ORIGINAL ARTICLE

Lung cancer patients in Queensland suffer delays in receiving radiation therapy – but not as a result of distance

B. H. Burmeister,[1] D. D. Zarate,[2] E. A. Burmeister,[1] H. E. Harden,[2] S. P. Colquist,[2] D. L. Cossio,[2] M. G. Poulsen,[3] M. Collins,[4] G. R. Pratt[5] and E. T. Walpole[1]

[1]Princess Alexandra Hospital, Woolloongabba, [2]Queensland Cancer Control Analysis Team, [3]Mater Centre, [5]The Royal Brisbane and Women's Hospital, Brisbane and [4]The Townsville Hospital, Townsville, Queensland, Australia

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Correspondence
Bryan H. Burmeister, Department of Radiation Oncology, University of Queensland, Princess Alexandra Hospital, Woolloongabba, Qld 4102, Australia. Email: bryan_burmeister@health.qld.gov.au

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Abstract

Aim: To determine whether lung cancer radiation therapy waiting times in Queensland public hospitals are associated with distance of residence from the nearest treatment facility.

Methods: Retrospective analysis of radiation therapy waiting times of 1535 Queensland residents who were diagnosed with lung cancer from 2000 to 2004 and received radiation therapy as initial treatment at a public hospital. The effect of distance of residence from treatment centre on median waiting time was analysed by quantile regression controlling for sex, age, lung cancer histology, stage and therapeutic intent.

Results: The median waiting time from diagnosis to start of radiation therapy was 33 days for all patients. There was no significant difference ($P = 0.141$) in median waiting times in relation to distance of residence from a treatment centre. However, in most patients, waiting times were significantly longer than recommended by the Royal Australian and New Zealand College of Radiologists. Curative patients waited longer than palliative patients, while patients with earlier stage cancer waited longer than those with more advanced disease.

Conclusion: Waiting times for radiation therapy among lung cancer patients in Queensland was not associated with distance from place of residence to the nearest public treatment facility. However, delays overall are excessive and are likely to worsen unless radiation treatment capabilities are enhanced to keep pace with population growth in Queensland.

Introduction

Lung cancer remains the most common fatal cancer affecting both men and women in Australia. Although the incidence of smoking is declining, many tertiary hospitals continue to receive large numbers of lung cancer referrals. This may be due to earlier detection, but increased awareness of treatment requirements among both general practitioners and specialists, as well as greater use of non-surgical therapies in both curative and palliative settings, could also be contributing to such increase in referrals. The number of lung cancer patients requiring radiation therapy, in particular, is likely to grow with the increased practice of multidisciplinary meetings and the greater use of radiation therapy as a palliative mode of care.

Access to radiation therapy is, however, a worldwide problem. Although it is probably the cheapest modality for cancer therapy,[1,2] many patients are unable to access it within recommended time frames. There are several reasons for this. As radiation therapy requires a complex infrastructure that is available only in larger cities, typically those with more than 100 000 residents, treatment capacities usually lag behind any increase in demand as a result of population growth and ageing. Furthermore, once the decision is made to treat the patient, the process

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of administering the therapy itself can take up to 2 weeks from consultation with a radiation oncologist to organizing of treatment plans by radiation therapy and allied health staff. Multidisciplinary meetings, which establish important links to regional centres[3] and are regarded as best practice for cancer patient care, may extend this process further.

Delivering radiation services to smaller communities is particularly difficult and has many challenges, such as attracting qualified staff, maintaining credentials in small centres, and the necessity in most cases of having a minimum of two linear accelerators so that patients can still be treated if one fails. The use of single machine units (SMUs) may improve access to radiation treatment, especially for much of rural Australia where the sparse population cannot support two machines. However, SMUs should only be used if they are linked to a major tertiary hub, where advice regarding more complex issues on management is accessible. This concept provides a balance between access and quality of care. The cost of providing such service at smaller hospitals is likely to be prohibitive as it requires a minimum complement of highly specialized staff in the form of radiation oncologists, radiation therapists, physicists and nurses with radiation oncology experience. Nonetheless, the concept of SMUs is cautiously being assessed at two locations in Victoria where distances from the capital city are relatively short.

Queensland is the fastest growing state in Australia with a current population of over 4 million and an annual growth rate of 5%. It is also the most decentralized state with at least 15 cities from the New South Wales border to Cairns having more than 50 000 residents and another 6 with 25 000–50 000 residents. Public radiation facilities are available in Brisbane and Townsville, while at the time of this study, private radiation centres were located in Brisbane, Gold Coast and Sunshine Coast. Although outreach clinics have been established to allow radiation oncologists from major treatment centres to service remote areas, it has been postulated that distance of residence from radiation facilities may be limiting access to this therapy in Queensland. To test this hypothesis, we analysed the waiting times from diagnosis to start of radiation therapy of lung cancer patients in Queensland in relation to their distance from the nearest radiation facility.

Methods

The patients included in this study were diagnosed with lung cancer between 1 January 2000 and 31 December 2004, resided in Queensland at the time of diagnosis, and were admitted to a Queensland Health (QH) public hospital as part of their work-up for radiation therapy as their initial treatment for lung cancer. Lung cancer patients were identified through the Queensland Cancer Registry. Primary site, histology, demographics and deaths data were obtained from the Queensland Cancer Registry, while stage and performance status were obtained from the Queensland Integrated Lung Cancer Outcomes Project database. Treatment information was obtained from several sources, including the QH Admitted Patient Data Collection, the Oncology Pharmacy System (Clinical Pharmacy Oncology Management System and iPharmacy) and the QH radiation therapy databases (Clinical Appointment System Royal Brisbane and Women's Hospital/Townsville and Princess Alexandra Hospital Radiation). Data linkage was performed by the Queensland Cancer Control Analysis Team under the auspices of a duly constituted Quality Assurance Committee. The analysis on which this report is based was devoid of any individual patient identifiers.

We divided the patients into three groups according to the distance by road between their residence (based on postal codes) and the nearest public radiation treatment facility:

- Those patients living within 50 km of the facility and presumably able to access treatment from home on a daily basis
- Those patients living 50–200 km from the facility and presumably able to go home for weekends only
- Those patients living more than 200 km from the facility and presumably spending the duration of therapy away from home

These definitions are similar to those used by the QH Patient Travel Subsidy Scheme for the funding of rural patients requiring medical treatment at centres far from their residence. The funding in this scheme is based on the road distance between the post office at the place of residence and the post office of the treatment facility.

Radiation therapy waiting time was defined as the number of days between the date of diagnosis and the date of commencement of radiation therapy. We used quantile regression[4] to model median waiting time as a function of distance of residence from therapy adjusted for sex, age, therapy intent, cancer histology and stage, and performance status based on ECOG score. We analysed survival from date of diagnosis after censoring patients who either died of causes other than lung cancer or did not have a death date as at 31 December 2007. We used Cox proportional hazards regression to estimate the effect of distance of residence on survival adjusted for the same set of covariates used in waiting time regression. All statistical analyses were performed using STATA (Statacorp LP, College Station, TX, USA).

Table 1 Characteristics of Queensland residents diagnosed with lung cancer in 2000–2004 and given radiation therapy at a public hospital as first treatment, by distance of residence from nearest radiation therapy centre

	Distance from therapy (km)			Total	Chi-squared
	<50	50–200	>200		*P*-value
Number of patients	952	203	380	1535	
Age at diagnosis in years, median (interquartile range)	70 (61–76)	68 (60–74)	67 (59–74)	69 (61–75)	
Sex (%)					0.368
Male	70	73	72	71	
Female	30	27	28	29	
Therapy intent (%)					0.001
Palliative	66	63	66	66	
Curative	30	28	26	29	
Others	4	9	8	5	
Histology (%)					0.731
NSCLC	91	89	92	91	
SCLC	6	7	6	6	
Unknown	3	4	2	3	
Clinical stage (%)					0.082
NSCLC					
I & II	21	17	15	19	
III	24	21	24	24	
IV	40	40	39	40	
Unknown NSCLC	7	10	13	9	
SCLC					
Limited	1	2	1	1	
Extensive	1	1	1	1	
Unknown SCLC	4	4	3	4	
Unknown stage and histology	2	5	4	2	
Performance status (%)					<0.001
Active or ambulatory	45	33	34	41	
Bedridden	12	10	11	11	
Unknown	43	57	55	48	

NSCLC, non-small cell lung cancer; SCLC, small cell lung cancer.

Results

Based on our data sources, a total of 8270 Queensland residents were diagnosed with lung cancer between 1 January 2000 and 31 December 2004. Of these, 1535 (19%) were admitted to a Queensland public hospital as part of their work-up for radiation therapy as their initial treatment and were therefore eligible for our analysis. Most of the patients who were considered ineligible for this study either did not have any record of treatment at a Queensland public hospital (27%) or did not receive radiation treatment as initial therapy at a public facility (54%).

Among the eligible patients (Table 1), the median age was 69 years (range 33–93). Seventy-one per cent of patients were male. Only 29% underwent curative therapy, while 66% received palliative treatment and the remainder had unspecified therapy. The majority (91%) of patients had non-small cell lung cancer (NSCLC), while 6% had small cell lung cancer (SCLC) and the remainder had lung cancer of uncertain histology. Sixty-two per cent of patients lived within 50 km of a radiation therapy centre, while 13% lived 50–200 km from a centre and 25% lived more than 200 km away.

The median waiting time from diagnosis to start of radiation therapy was 33 days for all patients (Table 2). Waiting time was significantly affected by cancer histology and stage as well as by therapeutic intent, but not by distance from residence to therapy centre. Multivariable adjustments through quantile regression did not change the pattern of differences in waiting times. In general, patients with more severe disease received treatment earlier than those with less severe cancer. Palliative patients commenced radiation treatment 11 days earlier ($P < 0.001$) than curative patients. Compared with NSCLC patients who waited 34 days for radiation therapy, SCLC patients waited 17 days less ($P = 0.015$). Among NSCLC patients, waiting times also decreased with disease progression; adjusted median waits were 48, 39 and 35 days for stages I/II, III and IV respectively.

Table 2 Median number of days (95% confidence interval) from diagnosis to start of radiation therapy for Queensland lung cancer patients diagnosed in 2000–2004 and given radiotherapy at a public hospital as first treatment

	n	Median waiting time (days post diagnosis)†		*P*-value
		Observed	Adjusted	
Distance from therapy (km)				
<50	952	33 (31–35)	33	—
50–200	203	33 (28–38)	34 (29–39)	0.617
>200	380	34 (30–38)	36 (32–40)	0.141
Sex				
Male	1091	34 (32–36)	34	—
Female	477	28 (25–31)	32 (28–35)	0.216
Age group (years)				
30–49	81	27 (17–37)	31 (23–38)	0.718
50–59	253	29 (23–35)	33 (27–38)	0.826
60–69	474	32 (28–36)	32	—
70–79	547	37 (32–42)	35 (31–39)	0.118
80+	180	33 (26–40)	32 (26–38)	1.000
Therapy intent				
Palliative	1011	27 (25–29)	27	—
Curative	444	47 (44–50)	38 (33–43)	<0.001
Unknown	80	28 (21–35)	24 (16–32)	0.775
Histology				
NSCLC	1399	34 (32–36)	34	—
SCLC	93	19 (13–25)	17 (3–31)	0.015
Unknown	43	32 (23–41)	29 (18–41)	0.413
Clinical stage				
NSCLC				
I & II	293	48 (45–51)	48	—
III	363	34 (29–39)	39 (34–45)	0.002
IV	608	26 (22–30)	37 (31–43)	<0.001
Unknown	135	35 (29–41)	45 (37–53)	0.456
SCLC				
Limited	21	33 (22–44)	33	—
Extensive	18	26 (10–42)	37 (9–49)	0.672
Unknown	54	15 (0–28)	29 (21–54)	0.621
Performance status				
Active or ambulatory	627	37 (34–40)	37	—
Bedridden	173	23 (16–30)	26 (20–31)	<0.001
Unknown	735	31 (27–35)	33 (29–37)	0.033

†Median waiting times were adjusted in a multivariable quantile regression model which includes all of the variables in this table. NSCLC, non-small cell lung cancer; SCLC, small cell lung cancer.

However, there was no significant difference in adjusted median waiting times between limited and extensive disease SCLC patients.

We limited our analysis of survival to NSCLC patients as the number of SCLC patients who received radiation therapy as initial treatment was too small. Our NSCLC survival data compare well with those from other published series.[5,6] Unadjusted median survivals were 21, 10 and 5 months for patients with stages I/II, III and IV disease respectively (Fig. 1). NSCLC patients who lived more than 200 km from a treatment centre had slightly worse survival than those who lived less than 50 km away (Fig. 2). This difference remained after adjustment for other variables (Fig. 3). The multivariable adjusted Cox hazard ratio for the >200 km distance group, relative to the <50 km group, was 1.14 (95% confidence interval: 1.00–1.31, $P = 0.057$).

Discussion

Evidence is still scant on the effect of treatment delays on cancer patient outcome, especially in lung cancer. An audit of 29 lung cancer patients who were awaiting radiation therapy in Scotland found that 21% of patients who were potentially curable became incurable during a waiting period with a median of 44 days from the date of

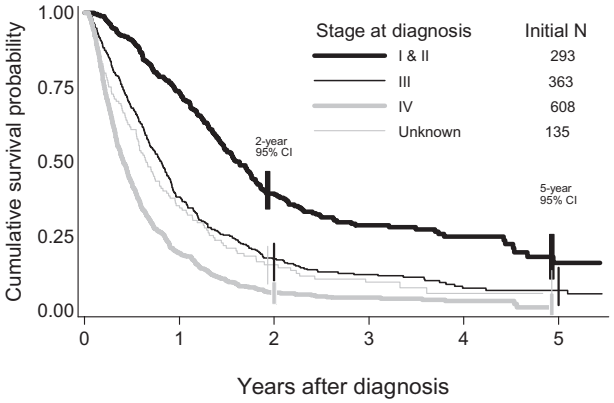

Figure 1 Kaplan–Meier cause-specific survival of non-small cell lung cancer patients whose first treatment was radiation therapy, according to cancer stage at diagnosis. 95% CI, 95% confidence interval.

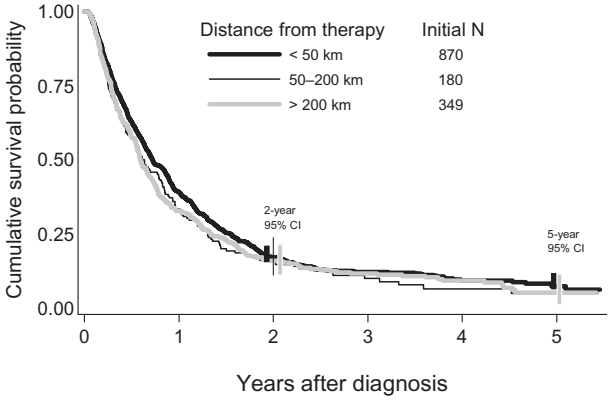

Figure 2 Kaplan–Meier cause-specific survival of non-small cell lung cancer patients whose first treatment was radiation therapy, according to distance from nearest radiation facility. 95% CI, 95% confidence interval.

radiation therapy request to the start of therapy.[7] A separate review indicated that survival was linked to the time taken in getting patients referred to a specialist centre rather than the time to commence therapy.[8] In a study of 23 NSCLC patients waiting for radiation therapy following induction chemotherapy, 41% of patients who were potentially curable became incurable during a waiting period with a mean of 80 days from the end of chemotherapy to the start of radiation therapy.[9] Treatment delays are also likely to cause significant psychological stress, especially in patients suffering from a serious illness, such as lung cancer, but this has yet to be studied systematically.

The Royal Australian and New Zealand College of Radiologists (RANZCR) has guidelines on acceptable time frames for patients requiring radiation therapy. For untreated NSCLC patients who require radiation therapy as initial treatment, a period of 14 days from being ready for care to commencement of therapy is considered acceptable. For limited stage SCLC, it is recommended that thoracic radiation therapy starts as soon as possible after commencing chemotherapy, although the optimum sequencing of the two modalities is still unknown.[10] In the UK, the National Health Service (NHS) targets a maximum of one-month wait from diagnosis to first treatment for all cancer patients, and various improvements in both

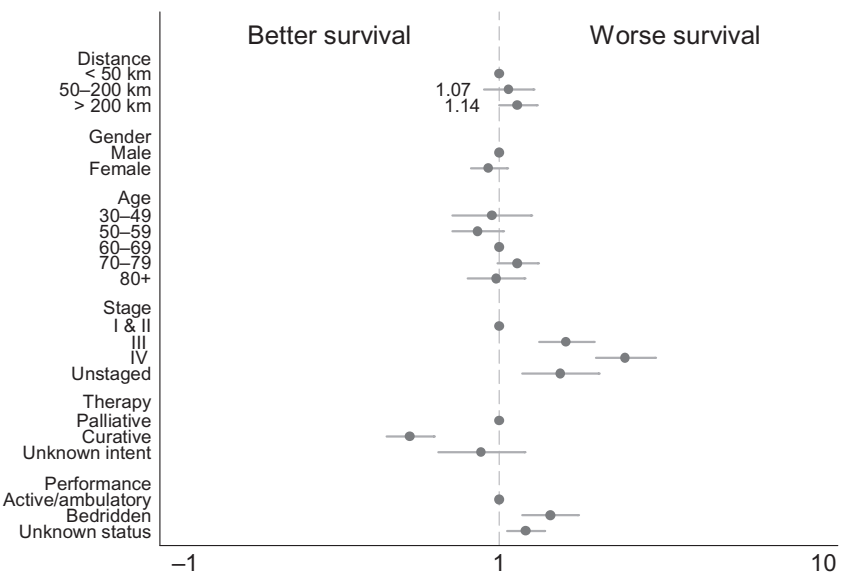

Figure 3 Hazard ratios from Cox proportional hazards regression of survival of non-small cell lung cancer patients as a function of distance from therapy, sex, age, clinical stage and therapy intent; horizontal bars represent 95% confidence intervals.

clinical practice and service efficiency have resulted in more than 90% of patients being treated within this time frame.[11]

It is well recognized throughout Australia that cancer patients suffer delays in commencing radiation therapy.[12] Our sample showed that only 19% of lung cancer patients had radiation therapy as part of their initial treatment through a public hospital facility. This figure is low when compared with expected rates of utilization, but could be explained by some patients receiving induction chemotherapy, as a result of being unable to access radiation therapy within a reasonable time frame. Similarly, some patients may never be referred for therapy because of poor performance status and comorbidity, in addition to remoteness from a therapy centre. Our study indicates that more than half of Queensland lung cancer patients who had radiation therapy as their first treatment waited longer than the maximum waiting period set by the RANZCR and the NHS. The situation is not much better in other parts of the world. In Ireland, the median delay from referral for treatment to commencement of treatment for lung cancer was 8 weeks.[13] In a review of 466 NSCLC patients in Sweden,[14] only 35% of patients received treatment within 4 weeks of their first hospital visit and 52% within 6 weeks. In both studies, the authors found that patients with longer waiting times had less advanced disease and better survival, suggesting that patients with more advanced disease were being 'fast-tracked' for treatment. We were unable to use the 'ready for care' date as recommended by the RANZCR as a start point for delay given the retrospective nature of the study. In a subsequent prospective review using the Queensland Oncology On Line database, the time between diagnosis and ready for care has been determined to be a median of 8 days for lung cancer.

These outcomes found by the published results above are consistent with our own finding of longer waiting times among curative and earlier stage patients compared with palliative and advanced stage patients. Although this is probably due mainly to the urgency of palliation in patients with advanced disease, additional diagnostic procedures among earlier stage patients could also partly account for their longer waiting times. The effect of diagnostic procedures on overall waiting times was highlighted by Salomaa *et al.*,[15] who found that diagnosis following initial specialist appointment took longer in patients with early stage lung cancer compared with those with advanced disease. Until recently, the limited availability of positron emission tomography (PET) scans has made delays in getting a radiation oncology consultation for patients with curable disease even longer. Nevertheless, the discrepancy in waiting times between curable and advanced stage lung cancer patients should be studied further to ensure that certain patients are not being targeted for earlier treatment at the expense of others.

The lack of association between radiation therapy waiting times and remoteness of residence among lung cancer patients in Queensland has an important implication for the ongoing discussion about possible inequities in cancer care between urban and rural patients. The Cancer Council of Queensland has shown that for all stages and histological subtypes, survival from lung cancer is poorer in rural areas, where the 5-year relative survival is 85–90% of that in the Brisbane region.[16] Our study was based partly on the same data sources as those used by the Cancer Council of Queensland, so our finding of poorer survival in NSCLC patients who lived more than 200 km from the nearest radiation therapy facility is not surprising. Our results suggest, however, that at least for NSCLC patients whose first treatment was radiation therapy, the poorer outcome of those from remote locations may not be due directly to delays in commencing treatment. If treatment delay contributes at all to such difference in survival, it may be through interaction with other risk factors, such as socio-economic status.

In a survey of cancer patients' attitude towards radiation therapy waiting times in Australia, Lehman *et al.*[17] found that patients undergoing treatment in regional centres were more prepared to stay away from home during treatment compared with their metropolitan counterparts, most likely because regional patients are accustomed to travel to urban centres for specialist services. This indicates that distance from treatment centre does not deter rural and regional patients from travelling for therapy, which is consistent with our own finding of similar waiting times between patients close to and those remote from radiation therapy facilities.

The scope of our study is limited to patients who received radiation therapy at public facilities. A number of radiation facilities operate in the private sector, particularly in the Gold Coast and the Sunshine Coast where all radiation centres are private. The number of lung cancer patients receiving private radiation therapy is unknown, but patient distribution for other types of care suggests that the majority of lung cancer treatments in Queensland are delivered at public facilities. Our data sources indicate, for instance, that 60% of all lung cancer surgery occur in public facilities and 73% of lung cancer patients have records of admission or care at public hospitals. If similar proportions apply to radiation therapy, then the results of this study are relevant to the majority of lung cancer patients receiving radiation treatment across the state.

Conclusion

Radiation therapy waiting times among lung cancer patients in Queensland are not related to distance from place of residence to the nearest public radiation treatment facility. However, radiation therapy delays across the state are excessive compared with published standards, and may worsen unless treatment capacities are increased to cope with the higher-than-national rate of population growth, ageing of the population and the increased utilization of radiation therapy in multidisciplinary cancer care. Further delays in treatment could lead to accelerated tumour progression, psychological stress and increased disparity in waiting times between patients with advanced disease and those with potentially curable cancer.

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