RESEARCH ARTICLE

Influence of Distance from Home to Hospital on Survival among Lung Cancer Patients

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Abstract

The objective of this study was to clarify how distance from place of residence to the nearest specialist cancer hospital affects the survival of lung cancer patients and the treatment received. For all patients diagnosed with lung cancer in the Aomori cancer registry database for the period from 2009 to 2011 (n=3,986). The distance to the treating hospital was measured as the straight line from a person's place of residence, and compared with findings from the Ederer II method for calculating relative survival. Information on treatments given was obtained by data extraction. We defined a hospital having respiratory medicine as specialist, while all private hospitals and clinics were included in the general category. Patients attending specialist hospitals numbered 2,548 (67.0%), and those treated at general institutions were 1,255 (33.0%). The patients who had the lowest relative survival with localized lesions lived <20 km from general hospitals and clinics. With more advanced stages, relative survival of those living <20 km from a specialist hospital was the lowest. Although the survival rate was not affected by the distance between place of residence and hospital, even when patients are diagnosed at a localized stage at a general hospital or clinic within 20 km from their home, they did survive longer in comparison with patients diagnosed at a specialist hospital.

Keywords: Lung cancer- distance- relative survival- stage at diagnosis- treatment

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Introduction

Cancer has been a leading cause of death in Japan since 1981, and lung cancer has been associated with high cancer related mortality rates since the 1990s (Vital Statistics Japan). Several studies have been published focusing on the role of accessibility to hospital on patient outcomes. In addition, most studies of the effects of distance to specialist care on treatment of lung cancer have been done. In South Africa, for example, the increased straight line distance from place of residence to the hospital providing therapy was associated with diagnosis at late stage among patients with breast cancer (Dickens et al., 2014). Among patients with cancer in US, the travel distance was also shown to influence the survival rate from metastatic disease at diagnosis (Massarweh et al., 2014). In Japan, by contrast, Takenaka et al. reported that distance from home to the treating hospital did not influence survival from non-small cell lung cancer among patients treated surgically (Takenaka et al., 2016). However, they did show that patients who travelled furthest tended to require interventions that were more aggressive.

Aomori prefecture has the highest age standardized mortality rate for cancer among the 47 prefectures of Japan; specifically, lung cancer is the leading cause of cancer related death in this prefecture (Vital Statistics Japan). The age standardized mortality rates for lung cancer are 50.3 per 100,000 males and 10.7 per 100,000 females in Aomori, which compares unfavorably with rates of 41.7 per 100,000 males and 11.4 per 100,000 females in Japan overall (Monitoring Cancer Incidence of Japan). Moreover, distance to hospital may be an important factor in Aomori because it covers a 9,606 km^2 area. To minimize the burden of long travel times to hospital, cancer treatment is usually provided at central hospitals located within 20 km of residences. However, many patients live outside these radii, so long transfers can be a serious problem; coupled with a poorer transportation infrastructure compared with urban prefectures, patients who live more than 20 km from hospitals may have increased difficulties attending hospital in Aomori. In turn, this poor accessibility may result in higher mortality rates for patients with cancer.

Understanding the influence of travel distance on the survival rates of patients with cancer in Aomori could be essential in our efforts to improve cancer control. If a relationship between the travel distance and survival rate can be shown, strategies can be put in place to improve accessibility and reduce any health disparities for those who live at greater distances from hospital. In this study, we therefore aimed to clarify how distance from place of residence to the nearest specialist cancer hospital (i.e.,

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distance from home to hospital) affects the survival rates of patients and the treatment provided by hospitals.

Material and Methods

Patients

We included data for all patients diagnosed with lung cancer in the Aomori cancer registry database for the period from 2009 to 2011. Patients were excluded if only the details of their death certificate were recorded.

Data collection

We obtained the following clinical and demographic information by data extraction: sex, date of birth, date of diagnosis, address, site of the primary tumor (International Classification of Disease for Oncology, Third Edition; site code C33–34), stage at diagnosis, initial method of detection, treatments given (none, surgery, and/or radiotherapy), and name of the hospital that first detected the lung cancer.

Hospitals

We grouped 17 public hospitals in which patients were treated as specialist as 'Specialist hospital' or other 112 general hospitals and clinics as 'General hospital and clinic'. We defined the hospital having respiratory medicine as Specialist hospital. All private hospital and clinic were included in General hospital and clinic.

Definitions

Age at diagnosis was classified into three groups: <65 years, 65–74 years, and ≥75 years. Stage at diagnosis was classified into localized (confined to the organ of origin), regional (invasion of adjacent organs or tissues and regional lymph node metastasis), distant (the presence of any distant metastasis), or unknown, according to the criteria of the annual report for Monitoring of Cancer Incidence in Japan. The initial method of detection was classified into four groups: cancer screening, medical examination, incidental finding, and other (unknown). Subjective symptoms were included in the other (unknown) category.

Distance to hospital

For the purposes of this report, the distance to hospital was measured as the straight line distance from a person's place of residence to his or her treating hospital. This distance was calculated using the Haversine formula (Equation 1). Patients' residential addresses were input as latitudeφ_1 and longitudeλ_1, and the hospital's address was input as latitudeφ_2 and longitudeλ_2. The coordinates were then converted to radians, with 6,378.137 km used as the average radius of the earth.

Eq. 1: $\text{Distance}=6{,}378.137\times\cos^{-1}(\sin\varphi_1\ \sin\varphi_2+\cos\varphi_1\ \cos\varphi_2\ \cos(\lambda_2-\lambda_1))$

To aid analysis, we classified the distance to hospital into four groups: <20 km, 20–39.9 km, ≥40 km, and unknown. If a patient attended a hospital outside the prefecture, they were included in the unknown group.

Relative survival

Relative survival is one of the standard method to adjust competing cause of death. Relative survival was calculated as a ratio of the observed survival in the cancer population and the expected survival estimated, if the cohort of patients had the same overall mortality rate as the background population (Parkin et al., 1991). Expected survival were calculated using annual national population life table to derive age and sex specific mortality profile of the background population for each year of diagnosis (Life Tables in Japan for 1962-2014). We used the Ederer II method for calculating relative survival.

Statistical analysis

Stata 13 (StataCorp LP, College Station, TX) was used for the input and analysis of data. To compare the characteristics of patients, age group, stage at diagnosis, distance group were analyzed by Kruskal-Wallis test. The 95% confidence intervals (95% CI) of relative survival rates were presented, but in the case of values of 0.00 and 1.00 or over because of small number of patients, they were not shown in the table.

Ethical considerations

This study was approved by the ethics committee of Hirosaki university graduate school of medicine.

Results

We included 3,986 patients with lung cancer in total, but excluded the data for 183 cases because they only included death certificate registrations.

Table 1 shows age specific characteristics of specialist hospital and general hospital and clinic. Patients attending specialist hospital were 2,548 (67.0%), and general hospital and clinic were 1,255 (33.0%). A higher proportion of patients aged ≥75 years was 786 (62.6%) in general hospital and clinic, and lower proportion of that was 1,046 (41.1%) in specialist hospital. The proportions of patients diagnosed at localized stage in specialist hospital was higher than that of general hospital and clinic in all age groups, and half of patients aged <65 years visited the general hospital and clinic was diagnosed late stage. Of the proportion of method of first detection of cancer screening in specialist hospital was higher than that of general hospital and clinic in all age groups. The proportion of patient who had surgery in specialist hospital was larger than that of general hospital and clinic in all age groups, especially <65 years and 65-74 years was three times larger.

Table 2 shows the characteristics of patients by their stage at diagnosis. The number of patients who was diagnosed localized stage in specialist hospital was 602 (23.6%) and distant stage was 907 (35.6%), on the other hand, the number of localized stage was 88 (7.0%) and distant stage was 409 (32.6%) in general hospital and clinic. When it was compared to localized groups specialist hospital and general hospital and clinic, the proportion of surgery and/or radiotherapy treatment in specialist hospital was higher. Notably, there was 10 times difference in the proportion of surgery.

Table 1. Age Specific Characteristics of Specialist Hospital and General Hospital and Clinic

		Specialist hospital				General hospital and clinic			
		<65 years	65-74 years	≥75 years	p	<65 years	65-74 years	≥75 years	p
		(n=692)	(n=810)	(n=1046)		(n=167)	(n=302)	(n=786)	
Sex	Men	469 (67.8)	593 (73.2)	762 (72.8)	0.125	127 (76.0)	240 (79.5)	548 (69.7)	0.034
	Women	223 (32.2)	217 (26.8)	284 (27.2)		40 (24.0)	62 (20.5)	238 (30.3)	
Stage at diagnosis	Localized	166 (24.0)	204 (25.2)	232 (22.2)	0.005	7 (4.2)	25 (8.3)	56 (7.1)	<0.001
	Regional	192 (27.7)	259 (32.0)	292 (27.9)		26 (15.6)	61 (20.2)	129 (16.4)	
	Distant	276 (39.9)	268 (33.1)	363 (34.7)		85 (50.9)	115 (38.1)	209 (26.6)	
	Unknown	58 (8.4)	79 (9.8)	159 (15.2)		49 (29.3)	101 (33.4)	392 (49.9)	
Method of first detection	Cancer screening	87 (12.6)	82 (10.1)	66 (6.3)	0.004	7 (4.2)	20 (6.6)	17 (2.2)	0.056
	Medical examination	119 (17.2)	66 (8.1)	56 (5.4)		8 (4.8)	13 (4.3)	20 (2.5)	
	Incidental finding	157 (22.7)	277 (34.2)	420 (40.2)		26 (15.6)	77 (25.5)	265 (33.7)	
	Other, unknown	329 (47.5)	385 (47.5)	504 (48.2)		126 (75.4)	192 (63.6)	484 (61.6)	
Surgical treatment	Surgery	238 (34.4)	273 (33.7)	176 (16.8)	<0.001	16 (9.6)	36 (11.9)	37 (4.7)	0.006
	Non-surgery	418 (60.4)	486 (60.0)	807 (77.2)		115 (68.9)	193 (63.9)	515 (65.5)	
	Unknown	36 (5.2)	51 (6.3)	63 (6.0)		36 (21.6)	73 (24.2)	234 (29.8)	
Radiotherapy treatment	Radiotherapy	207 (29.9)	211 (26.0)	259 (24.8)	0.141	39 (23.4)	32 (10.6)	55 (7.0)	<0.001
	Non-radiotherapy	447 (64.6)	548 (67.7)	720 (68.8)		91 (54.5)	196 (64.9)	495 (63.0)	
	Unknown	38 (5.5)	51 (6.3)	67 (6.4)		37 (22.2)	74 (24.5)	236 (30.0)	

n (%)

Table 2. The Characteristics of Patients by Their Stage at Diagnosis

		Specialist hospital					General hospital and clinic				
		Localized	Regional	Distant	Unknown	p	Localized	Regional	Distant	Unknown	p
		(n=602)	(n=743)	(n=907)	(n=296)		(n=88)	(n=216)	(n=409)	(n=542)	
Sex	Men	369 (61.3)	564 (75.9)	677 (74.6)	214 (72.3)	<0.001	60 (68.2)	167 (77.3)	306 (74.8)	382 (70.5)	0.355
	Women	233 (38.7)	179 (24.1)	230 (25.4)	82 (27.7)		28 (31.8)	49 (22.7)	103 (25.2)	160 (29.5)	
Method of first detection	Cancer screening	108 (17.9)	70 (9.4)	47 (5.2)	10 (3.4)	<0.001	10 (11.4)	6 (2.8)	11 (2.7)	17 (3.1)	<0.001
	Medical examination	94 (15.6)	82 (11.0)	52 (5.7)	13 (4.4)		7 (8.0)	12 (5.6)	10 (2.4)	12 (2.2)	
	Incidental finding	228 (37.9)	249 (33.5)	282 (31.1)	95 (32.1)		44 (50.0)	70 (32.4)	111 (27.1)	143 (26.4)	
	Other, unknown	172 (28.6)	342 (46.0)	526 (58.0)	178 (60.1)		27 (30.7)	128 (59.3)	277 (67.7)	370 (68.3)	
Surgical treatment	Surgery	395 (65.6)	209 (28.1)	64 (7.1)	19 (6.4)	<0.001	24 (27.3)	21 (9.7)	31 (7.6)	13 (2.4)	<0.001
	Non-surgery	204 (33.9)	530 (71.3)	838 (92.4)	139 (47.0)		59 (67.0)	184 (85.2)	359 (87.8)	221 (40.8)	
	Unknown	3 (0.5)	4 (0.5)	5 (0.6)	138 (46.6)		5 (5.7)	11 (5.1)	19 (4.6)	308 (56.8)	
Radiotherapy treatment	Radiotherapy	127 (21.1)	246 (33.1)	289 (31.9)	15 (5.1)	<0.001	11 (12.5)	59 (27.3)	50 (12.2)	6 (1.1)	<0.001
	Non-radiotherapy	472 (78.4)	494 (66.5)	613 (67.6)	136 (45.9)		69 (78.4)	148 (68.5)	340 (83.1)	225 (41.5)	
	Unknown	3 (0.5)	3 (0.4)	5 (0.6)	145 (49.0)		8 (9.1)	9 (4.2)	19 (4.6)	311 (57.4)	

n (%)

Table 3 shows the characteristics of patients by their distance from hospital. The number of patients lived <20 km from specialist hospital was 1,958 (76.8%) and ≥40 km was 201 (7.9%), and in patients lived general hospital and clinic, <20 km was 1,071 (85.3%) and ≥40 km was 48 (3.8%). Compared to specialist hospital and general hospital and clinic, the proportion of patients who was diagnosed localized stage in specialist hospital was higher than that of general hospital and clinic. Of the distant stage of stage at diagnosis, the proportion of ≥40 km from general hospital and clinic was the highest. Of the proportion of method of first detection of cancer screening, over 20 km from both hospital group was higher than <20 km. Of the proportion of having surgery, patients group of ≥40 km was the highest in both hospital group.

Table 4 shows the relative survival rates for 3 years from diagnosis. The patient who had the lowest relative survival in localized group lived <20 km from general hospital and clinic, and there was more than twice difference in comparison to other localized group. Of regional and distant stage, relative survival of the patients who lived <20 km from specialist hospital was the lowest.

Discussion

We examined the influence of distance from place of residence to hospital and relative survival rate of patients with lung cancer in Aomori, Japan. Most patients attended specialist hospital, and only minority of patients attended general hospital and clinic. In specialist hospital, patients were younger than the patient of general hospital and clinic, and a lot of patient were diagnosed localized stage. In general hospital and clinic, only a minority of patients was diagnosed in localized stage, and there were few the number of patients who had surgery even localized stage. Most patients attended hospitals within 20 km of where they lived. However, the number of patients who attended specialist hospital travelled more than 40 km was larger than general hospital and clinic. The patients who lived <20 km from general hospital and clinic had the lowest proportion of having surgery and/or radiotherapy. Of relative survival, the patients who was diagnosed in localized stage had longest relative survival in both type of hospital except for the patients who lived <20 km from general hospital and clinic. The patients who lived distance over 20 km from special hospital had higher relative survival than within 20 km.

The selection of the type of hospital most influenced the relative survival, regardless of distance to the hospitals. Keating et al. previously reported on the influence of distance from place of residence to hospital on decision making by patients with breast cancer who underwent surgery; interestingly, they concluded that distance was not a major factor for patients when choosing a hospital (Keating et al., 2016). This is consistent with our findings that distance did not affect patient selection of hospitals and that patients in Aomori tended to prefer hospitals that could provide surgical therapy. Specifically, only younger patients and patients who lived near specialist hospital may opt for treatment at specialist hospitals can undergo

Table 3. The Characteristics of Patients by Their Distance from Hospital

		Specialist hospital				General hospital and clinic				
		<20 km	20-39.9 km	≥40 km	p	<20 km	20-39.9 km	≥40 km	Unknown	p
		(n=1958)	(n=389)	(n=201)		(n=1071)	(n=100)	(n=48)	(n=36)	
Sex	Men	1400 (71.5)	287 (73.8)	137 (68.2)	0.529	776 (72.5)	79 (79.0)	35 (72.9)	25 (69.4)	0.727
	Women	558 (28.5)	102 (26.2)	64 (31.8)		295 (27.5)	21 (21.0)	13 (27.1)	11 (30.6)	
age	<65 years	493 (25.2)	133 (34.2)	66 (32.8)	<0.001	124 (11.6)	21 (21.0)	17 (35.4)	5 (13.9)	<0.001
	65-74 years	610 (31.2)	125 (32.1)	75 (37.3)		246 (23.0)	33 (33.0)	13 (27.1)	10 (27.8)	
	≥75 years	855 (43.7)	131 (33.7)	60 (29.9)		701 (65.5)	46 (46.0)	18 (37.5)	21 (58.3)	
Stage at diagnosis	Localized	395 (20.2)	139 (35.7)	68 (33.8)	<0.001	72 (6.7)	5 (5.0)	5 (10.4)	6 (16.7)	0.054
	Regional	568 (29.0)	116 (29.8)	59 (29.4)		185 (17.3)	14 (14.0)	11 (22.9)	6 (16.7)	
	Distant	752 (38.4)	100 (25.7)	55 (27.4)		343 (32.0)	38 (38.0)	22 (45.8)	6 (16.7)	
	Unknown	243 (12.4)	34 (8.7)	19 (9.5)		471 (44.0)	43 (43.0)	10 (20.8)	18 (50.0)	
Method of first detection	Cancer screening	149 (7.6)	58 (14.9)	28 (13.9)	0.015	26 (2.4)	10 (10.0)	4 (8.3)	4 (11.1)	0.26
	Medical examination	180 (9.2)	42 (10.8)	19 (9.5)		31 (2.9)	6 (6.0)	4 (8.3)	0 (0.0)	
	Incidental finding	676 (34.5)	112 (28.8)	66 (32.8)		324 (30.3)	18 (18.0)	15 (31.3)	11 (30.6)	
	Other, unknown	953 (48.7)	177 (45.5)	88 (43.8)		690 (64.4)	66 (66.0)	25 (52.1)	21 (58.3)	
Surgical treatment	Surgery	463 (23.6)	147 (37.8)	77 (38.3)	<0.001	68 (6.3)	9 (9.0)	7 (14.6)	5 (13.9)	0.144
	Non-surgery	1380 (70.5)	221 (56.8)	110 (54.7)		713 (66.6)	63 (63.0)	33 (68.8)	14 (38.9)	
	Unknown	115 (5.9)	21 (5.4)	14 (7.0)		290 (27.1)	28 (28)	8 (16.7)	17 (47.2)	
Radiotherapy treatment	Radiotherapy	505 (25.8)	123 (31.6)	49 (24.4)	0.152	96 (9.0)	12 (12.0)	14 (29.2)	4 (11.1)	0.004
	Non-radiotherapy	1333 (68.1)	244 (62.7)	138 (68.7)		684 (63.9)	57 (57.0)	27 (56.3)	14 (38.9)	
	Unknown	120 (6.1)	22 (5.7)	14 (7.0)		291 (27.2)	31 (31.0)	7 (14.6)	18 (50.0)	

n (%)

Table 4. The Relative Survival Rates for 3 Years from Diagnosis (95% CI)

	Specialist hospital			General hospital and clinic			
	<20 km	20-39.9 km	≥40 km	<20 km	20-39.9 km	≥40 km	Unknown
Localized	0.91 (0.86 to 0.96)	0.92 (0.85 to 0.99)	0.99 (0.91 to 1.07)	0.38 (0.10 to 0.66)	1.02	1.11	1.72
Regional	0.39 (0.29 to 0.49)	0.51 (0.33 to 0.69)	0.41 (0.11 to 0.71)	0.22 (-0.03 to 0.47)	0.18 (-0.84 to 1.20)	0	0
Distant	0.15 (-0.01 to 0.31)	0.24 (-0.09 to 0.57)	0.17 (-0.38 to 0.72)	0.07 (-0.29 to 0.43)	0	0.13 (-0.91 to 1.17)	0.21 (-1.31 to 1.73)

n (%)

surgery, on other words, no matter if they live within 20 km from general hospital and clinic, older patients and patients who cannot attend specialist hospitals cannot be given a surgery. Furthermore, even though the patients are diagnosed in localized stage at the general hospital and clinic within 20 km from their home, they cannot survive longer compared to the patients are diagnosed in specialist hospital.

Accordingly, the difference in therapy provided to patients with lung cancer was because of shortages in the numbers of specialist services. Therefore, through cooperation with specialist hospital that provide surgery, we should aim to provide appropriate follow-up, observation, and therapy at hospitals that patients can attend more easily. In line with this principle, material and human resources should be shared among hospitals to improve patient care. This may assist local government when selecting hospitals for patients, thereby improving overall accessibility to specialist services. Take particular note of radiotherapy, in previous study, the patients with localized prostate cancer are less likely to receive radiotherapy treatment the father away they live from a treatment facility (Muralidhar et al., 2016). Additionally, Lin et al. showed that an increased travel burden was associated with a decreased likelihood of receiving radiotherapy, in the patients with stage II/III rectal cancer (Lin et al., 2016). Therefore, the fact that many patients living over 20 km from hospital were treated with irradiation in Aomori might be great issue to be resolved.

In conclusion, we showed the relative survival was not affected by the distance between place of residence and hospital, we did uncover another important issue. The patients have regional disparity on treatment of surgery, even if they live near the hospital. To improve patient outcomes, we must make all reasonable efforts to minimize such rectifiable added burdens.

Limitations and strengths

Our study has some limitations. First, the distance traveled in a straight line do not exactly reflect the accessibility of a residence to a hospital, either in terms of actual travel time or actual distance, which are therefore unknown. However, this is the only objective measure of distance that has been widely used and accepted in previous studies (Dickens et al., 2014; Holmes et al., 2012), and as previously reported, straight line distance can represent almost all accessibility in US (Boscoe et al., 2012). Second, the stage at diagnosis may have been affected by differences in diagnostic accuracy between hospitals.

The major strength of our study are its coverage of the whole population in Aomori and our ability to link Aomori cancer registry. The major indicators of quality control, percentage of cancer cased identified with death certification only (DCO%) is 2.0% in Aomori cancer registry (Monitoring Cancer Incidence of Japan). Desired accuracy of DCO by international standard is less than 10%. Thus this study reflects actual state of lung cancer patients in Aomori, Japan.

Conflicts of Interest

The authors have no conflict of interest directly relevant to the content of this article.

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