

Effects of Multidisciplinary Team Care on Utilization of Emergency Care for Patients With Lung Cancer

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Worldwide, lung cancer is the most common cancer in terms of both incidence and mortality. In 2012, there were 1.8 million new cases and 1.59 million deaths caused by lung cancer.¹ Since 1998, lung cancer has been the leading cause of cancer death in Taiwan and worldwide.² Although progress has been made in the diagnosis and treatment of lung cancer, both the incidence and mortality rate of lung cancer have increased in recent years. Formal multidisciplinary team (MDT) care has been widely promoted worldwide to improve coordination, communication, and decision making in cancer management.^{3,4}

The Taiwan bureau of National Health Insurance has implemented “multidisciplinary team care for cancer patients” since April 2003 to enhance the quality of cancer diagnosis and treatment. The bureau emphasizes an MDT approach that provides a complete cancer treatment plan for patients. MDT care goes beyond such conventional treatments for lung cancer as surgical excision, radiation therapy, and chemotherapy. The MDT members can include related clinical physicians, nursing staff, a psychological consultant, a social worker, and a case manager to discuss a dedicated treatment plan and to integrate all treatments and care. Therefore, the patient with MDT care should benefit from stable and continuous care that includes regular outpatient visits and inpatient treatment, all arranged and coordinated through the case manager. The Bureau of National Health Insurance (NHI) paid additional fees to physicians to make MDT care financially appealing.

The MDT approach has been used for years in numerous countries. Studies from the United States, Germany, the United Kingdom, and Australia have demonstrated that an MDT that integrates surgeons, tumor physicians, radiology physicians, psychologists, psychiatrists, and dietitians can improve the quality of life for cancer patients,⁵ lower the cost of healthcare,⁶ and increase the satisfaction of treatment for patients,⁶ efficiency of treatment,^{4,5,7,8} and survival rate.^{9,10} In Taiwan, Wang et al found the relative risk of death was lower

ABSTRACT

Objectives

To improve the quality of care, multidisciplinary team (MDT) care was implemented in Taiwan. This study examined the relationship between MDT care and emergency department visits for lung cancer patients.

Study Design

A retrospective cohort study with MDT care participants and matched a double number of control group of non-participants was followed.

Methods

In this study, 22,817 patients with newly diagnosed lung cancer were recruited from 2005 to 2007 in Taiwan. Matching based on the propensity of receiving MDT care was used. A total of 8172 patients were observed in this study. A χ^2 , ANOVA, logistic regression, and Poisson regression were used to elucidate the effects of MDT care.

Results

The lung cancer patients participating in MDT had lower risk to visit an emergency department (ED) (OR = 0.89; 95% CI, 0.80-0.98), and the incidence rate ratio decreased by 11% (95% CI, -0.15 to -0.07). Gender, monthly salary, urbanization of the residence area, comorbid conditions, catastrophic illness/injury, treatment method, number of outpatient visits, length of stay, hospital ownership, level of hospital, and the age of the patient's physician were all significantly related to the frequency of ED visits ($P < .05$).

Conclusions

The frequency of emergency department visits of patients with MDT care was lower than that of those without it. The patients with MDT received enhanced care.

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Take-Away Points

- Multidisciplinary team care can improve the effectiveness of care for lung cancer patients.
- The incidence rate ratio of emergency department (ED) visits decreased 11% for lung cancer patients participating in MDT care.
- The primary cause of ED visits was fever for both the MDT participants (25.46%) and non-MDT participants (23.97%).

for oral cavity cancer in MDT care participants.⁴ Chen et al found that chronic kidney disease patients who participated in MDT had a better survival rate than nonparticipants have initiate renal replacement therapy instead of after MDT intervention.¹¹

Hospital emergency departments (EDs) are typically designed to manage emergent or unexpected situations and are generally crowded and busy.¹² As detailed in 1 study, in North Carolina in 2008, 0.9% of ED visits were cancer related; 7.7% of the state's cancer survivors visited the ED; and each ED visitor received 1.4 ED services per year on average.¹³ In Taiwan, in 2012, 1.9% of ED visits were cancer related.¹⁴ The reasons cancer patients seek ED services include pain, dyspnea, nausea, and vomiting, among others.^{13,15} Among cancer patients, lung cancer patients are, as a group, the likeliest of all to seek ED services.¹³ The main reasons that prompt the visits of lung cancer patient to EDs include respiratory symptoms, fever, neurological/psychiatric issues, and digestive complaints.¹⁶

The high percentage of ED visits for cancer patients has been recognized as an indicator that end-of-life cancer care is of less-than-ideal quality. Better care, it is believed, could help cancer patients avoid at least some of the urgent medical problems that necessitate ED visits.

Most studies on lung cancer in MDT care have been limited, sometimes because the sample size was small and sometimes because the focus was narrowly on survival. Few studies have examined the changes in the utilization of ED services after patients have become involved in MDT care. Therefore, this study investigates the influence of the participation and nonparticipation of patients in MDT care on the utilization of ED visits.

METHODS

Data Source

This retrospective and longitudinal cohort study analyzed the Cancer Dataset in the National Health Insurance Research Database (from 1997 to 2008) published by the Taiwan National Health Research Institutes and provided by the Bureau of National Health Insurance

of Taiwan. The database included the medical records of all individuals insured by National Health Insurance in Taiwan. At the end of 2009, a total of 23,026,000 people were insured, constituting 99.59% of Taiwan's population. From these data we could extrapolate the utilization of health services by the lung cancer patients in

Taiwan. The Bureau of National Health Insurance implemented MDT care in April 2003, and this study used the years of suffering from lung cancer diagnosis for cancer treatments (the major *International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]* code 140.x-293.x).

1. Participants. According to the database, 8172 lung cancer patients in Taiwan were newly diagnosed between 2005 and 2007. New patients defines a first-time lung cancer diagnosis based on *ICD-9-CM* code 162.x, and diagnosis following a year of chemotherapy, radiation treatment, surgery, or other cancer treatment. We followed up with each patient within 1 year after lung cancer diagnosis. We excluded those patients who had not received any treatment since their diagnosis, and we also excluded the patients who died within 1 month after diagnosis (N = 2050 patients). Since the physicians could decide whether the patients participated in the MDT care or not, the MDT participants might exhibit bias selection. Therefore, to reduce the bias selection from this population-based data, this study used a propensity score matching to evaluate the likelihood of participating in MDT care for each patient and so selected double patients as the control group. In beginning, the study selected 22,817 lung cancer patients which were 2736 patients who joined an MDT care and 20,081 patients who did not. After propensity score matching, there were 2724 MDT patients and double patients in non-MDT groups.

2. Variable Description and Definition. Independent variables included patients' gender, age, monthly salary, urbanization of their area of residence, Charlson Comorbidity Index (CCI) score, catastrophic illness number of cancer outpatient visits, number of hospitalizations, and participation status in MDT care, as well as certain characteristics of their hospital and physician. Dependent variables included whether the patients used ED service or not, and the frequency of ED use in the 12 months following diagnosis, excluding the utilization of the ED due to trauma.

Study participants were categorized by gender (male, female); age (divided into 7 groups from less than 24 years

■ **Table 1.** The Numbers of Lung Cancer Patients in Different Years Before and After PS Matching

Variables	Before PS Matching						After 2:1 PS Matching					
	Total		Non-MDT Care		MDT Care		Total		Non-MDT Care		MDT Care	
	N	%	N	%	N	%	N	%	N	%	N	%
Total	22,817	99.99	20,081	88.01	2736	11.99	8172	100.00	5448	66.67	2724	33.33
Year of diagnosis												
2005	7309	32.03	6347	86.84	962	13.16	2690	32.92	1733	64.42	957	35.58
2006	7501	32.87	6559	87.44	942	12.56	2750	33.65	1813	65.93	937	34.07
2007	8007	35.09	7175	89.61	832	10.39	2732	33.43	1902	69.62	830	30.38

MDT indicates multidisciplinary team; PS, propensity score.

to 75 years and older); monthly salary (divided into 8 groups); urbanization of residence area (noted on a scale of 1 to 7,¹⁷ with 1 being the most urban and 7 the least); CCI score (the extent of comorbidity was adapted by Deyo);¹⁸ catastrophic illness (yes or no); number of cancer outpatient visits (divided into 7 groups, from 0 visits to 26 and above); length of stay of hospitalization due to lung cancer within 1 year after cancer diagnosis (LOS; divided into 5 groups); ownership of the hospital visited most frequently (public or non-public); level of that hospital (first level, second level, third level, and clinic); and characteristics (gender, age) of the patient's physician.

3. The study used descriptive statistics, χ^2 test, *t* test, and ANOVA to analyze the characteristics of demography, health status, disease treatment method, utilization of healthcare within 1 year, hospital and physicians' characteristics, and the differences in ED visits between those who did and did not participate in MDT care. Logistic regression and Poisson regression were used to analyze the inference factors of probability and frequency of ED visits between the patients who did and did not participate in MDT care. All analyses were performed using the sets statistical package version 9.2.

RESULTS

Table 1 and **Table 2** show the characteristic distribution before and following PSM of the sample. Following PSM, 8172 subjects were selected for this study. The characteristics included the gender, age, monthly salary, urbanization of residence area, CCI score, catastrophic illness, and treatment methods of MDT and non-MDT participants. The differences between the 2 groups on all these variable measures were not statistically significant ($P > .05$).

Table 3 shows the top 20 causes of lung cancer patients' ED visits. The primary cause was fever for both the MDT participants (25.46%) and non-MDT partici-

pants (23.97%), followed by dyspnea and respiratory abnormalities; chest pain; abdominal pain; and dizziness and fainting. These 5 causes account for 64% of the reasons lung cancer patients visited the ED, and there were no significant differences in this regard between the MDT and non-MDT patients. Fewer MDT participants (7.94%) visited EDs because of lung cancer-related chest pains than non-MDT participants (10.2%). Furthermore, fewer MDT participants (1.06%) visited EDs because of coughing than did non-MDT participants (2.24%). Among the top 20 causes for the MDT participants' ED care visits were general symptoms (2.88%), convulsions (1.7%), and other nervous and musculoskeletal system symptoms (0.59%). For non-MDT participants, ED visit reasons included alteration of consciousness (1.75%), shock without mention of trauma (1.02%), and general symptoms (0.56%). **Table 4** shows comparisons of the ED care uses of MDT participants and non-MDT participants who had different demographic variables and treatment characteristics. Before controlling for other factors, the results of the χ^2 test showed that MDT participants had less chance to use ED services than non-MDT participants, but not significantly. However, the number of ED care visits in MDT participants was significantly less than non-MDT participants. Patients who had higher percentages of ED service uses tended to be male; have monthly salaries lower than NT\$57,800 (New Taiwan dollars); live in less urbanized areas; have CCI scores greater than 7; have a greater likelihood to have suffered a catastrophic illness; have made more cancer outpatient visits; have had a longer LOS. Patients who made more ED visits also tended to be receiving the treatments of radiology therapy; or radiology therapy + chemotherapy; or surgery + radiology therapy + chemotherapy. In addition, patients who are treated by physicians aged 44 years or less have significantly higher percentages of ED service use ($P < .05$).

Table 2. Demographic and Relative Variables Before and After Propensity Score Matching for Lung Cancer Patients (2005-2007)

Variables	Before Propensity Score matching (N = 22,817)					After 2:1 Propensity Score matching (N = 8172)						
	Nonparticipants		Participants		P	Nonparticipants		Participants		P		
	N	%	N	%		N	%	N	%			
Gender						.017						.412
Male	13,044	88.4	1713	11.6		3470	67.0	1709	33.0			
Female	7036	87.3	1023	12.7		1978	66.1	1015	33.9			
Missing	1	—	—	—		—	—	—	—			
Age (years)						<.001						.728
≤24	89	89.0	11	11.0		3	60.0	2	40.0			
24~34	130	86.1	21	13.9		39	65.0	21	35.0			
34~44	719	85.7	120	14.3		199	62.4	120	37.6			
44~54	2313	84.0	442	16.0		904	67.2	442	32.8			
54~64	3559	85.3	615	14.7		1211	66.3	615	33.7			
64~74	5650	86.9	854	13.1		1755	67.3	851	33.7			
>74	7621	91.9	673	8.1		1337	66.5	673	33.5			
Mean of age (mean ± sd)	68.02	±12.75	64.56	±12.11		64.85	±12.04	64.56	±12.11			
Monthly salary (in New Taiwan dollars)						<.001						.977
Insured dependent	6196	88.5	802	11.5		1593	66.8	793	33.2			
≤17,280	5008	91.3	480	8.8		959	66.6	480	33.4			
17,281-22,800	6547	86.0	1069	14.0		2177	67.1	1066	32.9			
22,801-28,800	627	85.3	108	14.7		193	64.1	108	35.9			
28,801-36,300	496	84.2	93	15.8		171	64.8	93	35.2			
36,301-45,800	614	85.8	102	14.3		200	66.2	102	33.8			
45,801-57,800	195	87.1	29	13.0		60	64.7	29	32.6			
57,801-72,800	216	87.1	32	12.9		56	63.6	32	36.4			
≥72,801	182	89.7	21	10.3		39	65.0	21	35.0			
Urbanization of residence area						<.001						.519
Levels 1	5323	88.6	686	11.4		1299	65.4	686	34.6			
Levels 2 & 3	8788	89.0	1089	11.0		2222	67.1	1089	32.9			
Levels 4 & 5	3911	86.1	632	13.9		1258	66.6	632	33.4			
Levels 6 & 7	1992	86.2	320	13.8		669	67.6	317	32.2			
Missing	67	—	9	—		—	—	—	—			
Charlson Comorbidity Index						.003						.485
≤3	15,016	88.1	2023	11.9		4112	67.1	2014	32.9			
4-6	327	86.5	51	13.5		88	63.3	51	36.7			
7-9	2665	88.8	336	11.2		641	65.7	335	34.3			
10-12	87	95.6	4	4.4		4	50.0	4	50.0			
≥13	1986	86.1	322	14.0		603	65.3	320	34.7			
Catastrophic illness												.317
Without	16,371	87.7	2290	12.3		4610	66.9	2281	33.1			
With	3710	89.3	446	10.7		838	65.4	443	34.6			
Treatment methods						<.001						.682
Surgery	7605	96.5	275	3.5		550	66.6	274	33.3			
Radiology therapy	388	86.4	61	13.6		107	64.1	60	35.9			
Chemotherapy	440	91.1	43	8.9		75	64.1	42	35.9			
Surgery + radiology therapy	2398	86.5	374	13.5		731	66.2	374	33.9			
Surgery + chemotherapy	4578	88.0	625	12.0		1284	67.3	625	32.7			
Radiology therapy + chemotherapy	261	72.9	97	27.1		153	61.9	94	38.1			
Surgery + radiology therapy + chemotherapy	4410	77.8	1261	22.2		2548	67.0	1255	33.0			
Other	1	100.0	0	0.0		0	0.0	0	0.0			

■ **Table 3.** The Top 20 Leading Causes of ED Care Visits Among Lung Cancer Patients by MDT Participation Status

Non-Multidisciplinary Team Participants (N = 5448)				Multidisciplinary Team Participants (N = 2724)			
Ranking	Symptoms	Total Number	%	Ranking	Symptoms	Total Number	%
1	Fever	684	23.97	1	Fever	433	25.46
2	Dyspnea and respiratory abnormalities	386	13.53	2	Dyspnea and respiratory abnormalities	225	13.23
3	Chest pain	291	10.20	3	Abdominal pain	170	9.99
4	Abdominal pain	268	9.39	4	Chest pain	135	7.94
5	Dizziness and fainting	214	7.50	5	Dizziness and fainting	122	7.17
6	Nausea and vomiting	194	6.80	6	Nausea and vomiting	119	7.00
7	Malaise and fatigue	121	4.24	7	Malaise and fatigue	88	5.17
8	Hemoptysis	120	4.21	8	Hemoptysis	56	3.29
9	Headache	76	2.66	9	General symptoms	49	2.88
10	Cough	64	2.24	10	Retention of urine	36	2.12
11	Sleep disturbances	62	2.17	11	Headache	34	2.00
12	Alteration of consciousness	50	1.75	12	Convulsions	29	1.70
13	Retention of urine	46	1.61	13	Sleep disturbances	29	1.70
14	Edema	35	1.23	14	Syncope and collapse	20	1.18
15	Shock without mention of trauma	29	1.02	15	Edema	18	1.06
16	Syncope and collapse	25	0.88	16	Cough	18	1.06
17	Palpitations	20	0.70	17	Palpitations	11	0.65
18	Other symptoms involving digestive system	19	0.67	18	Other symptoms involving nervous and musculoskeletal systems	10	0.59
19	Other general symptoms	16	0.56	19	Other symptoms involving digestive system	10	0.59
20	Dysuria	15	0.53	20	Dysuria	10	0.59

Patients in our study with the following characteristics had greater mean numbers of ED service uses: non-MDT participants (mean = 1.53 ± standard deviation [SD] 2.63); those between 25 and 34 years of age (mean = 2.37 ± SD 4.25); those with a CCI score of 12 or greater (mean = 2.67 ± SD 3.01); residing at levels 4 and 5 in urbanization of residence area (mean = 1.66 ± SD 3.21); those with catastrophic injury or illness beyond lung cancer (mean = 1.51 ± SD 2.54); greater number of cancer outpatient visits (mean = 1.66 ± SD 2.93), longer LO; and receiving surgery + radiology therapy + chemotherapy (mean = 1.72 ± SD 2.98). Patients who are treated at public hospitals have greater mean numbers of ED service uses (mean = 1.57 ± SD 2.39), and patients who are treated by physicians 55 years or older have the smallest mean number of ED service uses (mean = 1.14 ± 1.88), a statistically significant difference in comparison to patients treated by younger physicians ($P < .05$).

Table 5 shows the results of the logistic regression and Poisson regression that were performed on the variables.

The results of the logistic regression show that MDT participants have a lower likelihood of seeking ED services (OR = 0.89; 95% CI, 0.80-0.98), which differs significantly from non-MDT participants ($P = .022$). Female patients are less likely to visit EDs compared with male patients (OR = 0.73; 95% CI, 0.66-0.81); patients with monthly salaries either between NT\$57,801 and NT\$72,800, or NT\$72,800 or more, are less likely to visit EDs compared with patients with premium-based monthly salaries of NT\$17,280 or less (OR = 0.34; 95% CI, 0.21-0.54; OR = 0.52; 95% CI, 0.30-0.91); patients with CCI scores between 4 and 6, between 7 and 9, between 10 and 12, and 12 or greater are more likely to visit EDs compared with patients with CCI scores of 3 or less (OR = 1.60; 95% CI, 1.28-2.00; OR = 2.62; 95% CI, 2.13-3.22; OR = 3.70; 95% CI, 3.02-4.52; OR = 7.82; 95% CI, 5.31-11.54); and patients with catastrophic illness are more likely to visit EDs compared with patients without catastrophic illness (OR = 2.94; 95% CI, 2.01-4.31). Patients receiving surgery + radiology therapy, surgery + chemotherapy, radiology therapy + chemotherapy, and

■ **Table 4.** Rate of ED Service Use and Mean Number of ED Care Visits by Lung Cancer Patients

Variables	No ED Service Use		ED Service Use		P	N	Mean	SD	P
	N	%	N	%					
Participation status of MDT					.167				.024
Non-participants	2319	42.57	3129	57.43		5448	1.53	2.63	
Participants	1204	44.20	1520	55.80		2724	1.40	2.29	
Gender					<.001				<.001
Male	2109	40.72	3070	59.28		5179	1.57	2.76	
Female	1414	47.24	1579	52.76		2993	1.34	2.05	
Age (years)					.506				.026
≤24	3	60.00	2	40.00		5	0.40	0.55	
25-34	20	33.33	40	66.67		60	2.37	4.25	
35-44	145	45.45	174	54.55		319	1.33	1.88	
45-54	599	44.50	747	55.50		1346	1.54	3.48	
55-64	773	42.33	1053	57.67		1826	1.50	2.32	
65-74	1114	42.75	1492	57.25		2606	1.53	2.47	
≥75	869	43.23	1141	56.77		2010	1.38	1.97	
Mean of age (mean ± SD)	64.66	±12.07	64.82	±12.06		8172	64.75	±12.06	
Monthly salary (NT\$)					<.001				.148
Insured dependent	1043	43.71	1343	56.29		2386	1.53	2.64	
≤17,280	640	44.48	799	55.52		1439	1.38	2.01	
17,281-22,800	1331	41.04	1912	58.96		3243	1.55	2.78	
22,801-28,800	134	44.52	167	55.48		301	1.37	2.25	
28,801-36,300	118	44.70	146	55.30		264	1.46	1.96	
36,301-45,800	129	42.72	173	57.28		302	1.32	1.84	
45,801-57,800	37	41.57	52	58.43		89	1.53	2.29	
57,801-72,800	57	64.77	31	35.23		88	1.07	2.09	
≥72,801	34	56.67	26	43.33		60	1.02	1.66	
Urbanization of residence area					.039				.002
Levels 1	898	45.24	1087	54.76		1985	1.35	2.49	
Levels 2 & 3	1441	43.52	1870	56.48		3311	1.48	2.24	
Levels 4 & 5	781	41.32	1109	58.68		1890	1.66	3.21	
Levels 6 & 7	403	40.87	583	59.13		986	1.45	1.90	
Charlson Comorbidity Index					<.001				<.001
≤3	372	66.19	190	33.81		562	0.66	1.37	
4-6	662	54.89	544	45.11		1206	1.01	1.80	
7-9	1071	44.24	1350	55.76		2421	1.33	1.89	
10-12	1371	36.38	2398	63.62		3769	1.79	3.05	
≥13	47	21.96	167	78.04		214	2.67	3.01	
Catastrophic illness					<.001				<.001
No	140	76.09	44	23.91		184	0.46	1.14	
Yes	3383	42.35	4605	57.65		7988	1.51	2.54	

(Continued)

■ **Table 4.** Rate of ED Service Use and Mean Number of ED Care Visits by Lung Cancer Patients (*Continued*)

Variables	No ED Service Use		ED Service Use		P	N	Mean	SD	P
	N	%	N	%					
Number of cancer outpatient visits					<.001				<.001
0	217	76.95	65	23.05		282	0.32	0.68	
1-5	388	49.81	391	50.19		779	0.93	1.30	
6-10	286	41.75	399	58.25		685	1.27	1.69	
11-15	252	39.19	391	60.81		643	1.51	2.11	
16-20	293	39.22	454	60.78		747	1.58	2.18	
21-25	323	42.06	445	57.94		768	1.59	2.49	
≥26	1764	41.33	2504	58.67		4268	1.66	2.93	
LOS of inpatient (days)					<.001				<.001
0~15	1141	77.51	331	22.49		293	0.73	1.47	
15~30	12,266	68.71	5587	31.29		3396	0.95	1.62	
31~45	3022	50.37	2978	49.63		1537	1.55	2.25	
46~60	1559	42.04	2149	57.96		1026	1.83	2.34	
≥61	2244	32.86	4585	67.14		1920	2.31	3.76	
Treatment method					<.001				<0.001
Surgery	501	60.8	323	39.20		824	0.79	1.41	
Radiology therapy	70	41.92	97	58.08		167	1.57	1.91	
Chemotherapy	53	45.30	64	54.70		117	1.04	1.54	
Surgery + radiology therapy	506	45.79	599	54.21		1105	1.19	1.71	
Surgery + chemotherapy	834	43.69	1075	56.31		1909	1.52	2.37	
Radiology therapy + chemotherapy	102	41.30	145	58.70		247	1.47	2.00	
Surgery + radiology therapy + chemotherapy	1457	38.31	2346	61.69		3803	1.72	2.98	
Hospital ownership					.858				.033
Public	1102	42.95	1464	57.05		2566	1.57	2.39	
Non-public	2421	43.19	3185	56.81		5606	1.45	2.58	
Hospital level					.127				.969
First-level hospital	12,162	56.78	9256	43.22		4657	1.50	2.18	
Second-level hospital	7264	55.65	5788	44.35		3202	1.47	2.30	
Third-level hospital	693	58.14	499	41.86		2637	1.52	2.01	
Clinics	113	56.50	87	43.50		50	1.46	1.93	
Physician's gender					.952				.973
Male	3362	43.10	4439	56.90		7801	1.49	2.53	
Female	161	43.40	210	56.60		371	1.48	2.38	
Physician's age (years)					<.001				.001
≤34	276	38.71	437	61.29		713	1.50	2.14	
35-44	1621	42.15	2225	57.85		3846	1.54	2.30	
45-54	1243	43.39	1622	56.61		2865	1.50	2.99	
≥55	383	51.20	365	48.80		748	1.14	1.88	

ED indicates emergency department; NT\$, New Taiwan dollars.

surgery + radiology therapy + chemotherapy are more likely to visit EDs compared with patients receiving only surgeries (OR = 1.89; 95% CI, 1.54-2.32; OR = 1.90; 95% CI, 1.57-2.30 < OR = 1.61; 95% CI, 1.17-2.22; OR = 2.71; 95% CI, 2.25-3.28). Patients with more than 1 outpatient visit

and treated in a district hospital, rather than a first-level hospital, are more likely to visit the ED. Patients with longer LOS and who are treated by physicians over 35 years of age are less likely to visit the ED. These differences are all statistically significant ($P < .05$).

■ **Table 5.** Results of Logistic Regression and Poisson Regression for ED Visits Among Lung Cancer Patients

Variables	Logistic Regression (N = 8172)			Poisson Regression (N = 8172)			
	OR	95% CI	P	β	SE	95% CI	P
Intercept				-2.76	0.72	-4.18 to -1.34	<.001
Participation status of multidisciplinary team care							
Nonparticipants (reference)							
Participants	0.89	0.80-0.98	.022	-0.11	0.02	-0.15 to -0.07	<.001
Gender							
Male (reference)							
Female	0.73	0.66-0.81	<.001	-0.18	0.02	-0.22 to -0.14	<.001
Age (years)							
≤ 24 (reference)							
25-34	1.40	0.19-10.08	.741	1.23	0.71	-0.16 to 2.63	.084
35-44	0.87	0.13-5.88	.888	0.67	0.71	-0.72 to 2.06	.342
45-54	0.92	0.14-6.16	.935	0.82	0.71	-0.57 to 2.21	.247
55-64	0.96	0.14-6.36	.963	0.72	0.71	-0.67 to 2.11	.309
65-74	0.89	0.13-5.89	.901	0.69	0.71	-0.69 to 2.08	.328
≥ 75	1.02	0.15-6.80	.982	0.74	0.71	-0.65 to 2.13	.295
Monthly salary (NT\$)							
$\leq 17,280$ (reference)							
Insured dependent	1.02	0.88-0.18	.812	0.10	0.03	0.04-0.16	.001
17,281–22,800	1.10	0.95-1.27	.198	0.06	0.03	0.00-0.11	.041
22,801–28,800	1.06	0.81-0.40	.679	-0.01	0.06	-0.12 to 0.10	.851
28,801–36,300	0.99	0.74-0.32	.938	0.00	0.06	-0.12 to 0.11	.935
36,301–45,800	0.94	0.71-1.23	.643	-0.17	0.06	-0.28 to -0.06	.003
45,801–57,800	1.09	0.68-1.75	.731	-0.02	0.09	-0.20 to 0.15	.789
57,801–72,800	0.34	0.21-0.54	<.001	-0.43	0.11	-0.64 to -0.22	<.001
$\geq 72,801$	0.52	0.30-0.91	.022	-0.42	0.13	-0.68 to -0.17	.001
Urbanization of residence area							
Levels 1 (reference)							
Levels 2 & 3	1.00	0.88-1.13	.988	0.06	0.02	0.01-0.11	.016
Levels 4 & 5	1.06	0.91-1.24	.430	0.16	0.03	0.10-0.22	<.001
Levels 6 & 7	1.07	0.89-1.29	.479	0.03	0.04	-0.04 to 0.10	.361
Charlson comorbidity index							
≤ 3 (reference)							
4-6	1.60	1.28-2.00	<.001	0.39	0.06	0.27-0.50	<.001
7-9	2.62	2.13-3.22	<.001	0.65	0.06	0.54-0.76	<.001
10-12	3.70	3.02-4.52	<.001	0.95	0.05	0.85-1.06	<.001
≥ 13	7.82	5.31-11.54	<.001	1.32	0.07	1.19-1.45	<.001
Catastrophic illness/injury							
No (reference)							
Yes	2.94	2.01-4.31	<.001	0.63	0.11	0.41-0.85	<.001

(Continued)

Table 5. Results of Logistic Regression and Poisson Regression for ED Visits Among Lung Cancer Patients [

Variables	Logistic Regression (N = 8172)			Poisson Regression (N = 8172)			
	OR	95% CI	P	β	SE	95% CI	P
Treatment method							
Surgery (reference)							
Radiology therapy	1.42	0.99-2.04	.058	0.32	0.07	0.18-0.47	<.001
Chemotherapy	1.29	0.85-1.95	.237	-0.09	0.10	-0.28 to 0.11	.382
Surgery + radiology therapy	1.89	1.54-2.32	<.001	0.34	0.05	0.24-0.43	<.001
Surgery + chemotherapy	1.90	1.57-2.30	<.001	0.52	0.05	0.43-0.61	<.001
Radiology therapy + chemotherapy	1.61	1.17-2.22	.003	0.26	0.07	0.13-0.40	<.001
Surgery + radiology therapy + chemotherapy	2.71	2.25-3.28	<.001	0.66	0.04	0.57-0.74	<.001
Number of cancer outpatient visits							
0 (reference)							
1-5	2.55	1.83-3.54	<.001	0.73	0.11	0.51-0.95	<.001
6-10	3.01	2.15-4.23	<.001	0.90	0.11	0.68-1.12	<.001
11-15	3.16	2.24-4.45	<.001	1.03	0.11	0.81-1.25	<.001
16-20	3.16	2.25-4.42	<.001	1.07	0.11	0.85-1.29	<.001
21-25	2.53	1.80-3.54	<.001	1.02	0.11	0.80-1.24	<.001
≥26	2.24	1.64-3.06	<.001	0.99	0.11	0.77-1.20	<.001
LOS of inpatient							
0-15 (reference)							
15-30	0.51	0.45-0.57	<.001	-0.46	0.02	-0.50 to -0.42	<.001
31-45	0.38	0.33-0.44	<.001	-0.66	0.03	-0.72 to -0.60	<.001
46-60	0.27	0.22-0.33	<.001	-1.01	0.05	-1.11 to -0.92	<.001
≥61	0.18	0.15-0.22	<.001	-1.24	0.05	-1.33 to -1.15	<.001
Hospital ownership							
Public (reference)							
Private	1.00	0.90-1.12	.953	-0.11	0.02	-0.15 to -0.06	<.001
Hospital level							
First-level hospital							
Second-level hospital	0.94	0.84-1.05	.250	0.07	0.02	0.03-0.11	.001
Third-level hospital	1.41	1.06-1.88	.018	0.27	0.05	0.17-0.37	<.001
Clinic	0.96	0.52-1.78	.908	0.08	0.12	-0.15 to 0.31	.497
Physician's gender							
Male (reference)							
Female	1.04	0.83-1.31	.716	0.10	0.04	0.01-0.19	.024
Physician's age (years)							
≤34 (reference)							
35-44	0.76	0.64-0.91	.003	-0.04	0.03	-0.10 to 0.03	.287
45-54	0.70	0.59-0.85	<.001	-0.07	0.04	-0.14 to 0.00	.045
≥55	0.59	0.47-0.74	<.001	-0.21	0.05	-0.30 to -0.12	<.001

CI indicates confidence interval; ED, emergency department; OR, odds ratio; SE, standard error.

The results of the Poisson regression showed that after controlling for the other variables, the MDT participants visited EDs fewer times compared with non-MDT participants ($\beta = -0.09$; 95% CI, -0.13 to 0.05). Female patients visited EDs fewer times compared with male patients ($\beta = -0.18$; 95% CI, -0.22 to 0.14). Patients who were insured dependents or who had monthly salaries between NT\$17,281 and NT\$22,800 visited EDs more times compared with patients with monthly salaries of NT\$17,280 or less ($\beta = 0.10$; 95% CI, 0.04 - 0.16 ; and $\beta = 0.06$; 95% CI, 0.00 - 0.11), whereas patients with premium-based monthly salaries between NT\$36,301 and NT\$45,800, between NT\$57,801 and NT\$72,800, and NT\$72,801 or greater, visited EDs fewer times compared with patients having monthly salaries of NT\$17,280 or less ($\beta = -0.17$; 95% CI, -0.28 to 0.06 ; $\beta = -0.43$; 95% CI, -0.64 to 0.22 ; $\beta = -0.42$; 95% CI, -0.68 to 0.17). Patients at levels 2 and 3 and 4 and 5 of urbanization of residence area visited EDs more times compared with patients at level 1 (the most urban) of urbanization of residence area ($\beta = 0.06$; 95% CI, 0.01 - 0.11 ; $\beta = 0.16$; 95% CI, 0.13 - 0.22). Patients with CCI scores between 4 and 6, between 7 and 9, between 10 and 12, and of 12 or more visited EDs more times compared with patients with CCI scores of 3 or less ($\beta = 0.39$; 95% CI, 0.27 - 0.50 ; $\beta = 0.65$; 95% CI, 0.54 - 0.76 ; $\beta = 0.95$; 95% CI, 0.85 - 1.06 ; and $\beta = 1.32$; 95% CI, 1.19 - 1.45). Patients with catastrophic illness visited EDs more times compared with patients without them ($\beta = 0.63$; 95% CI, 0.41 - 0.85). Patients receiving radiology therapy, surgery + radiology therapy, surgery + chemotherapy, radiology therapy + chemotherapy, and surgery + radiology therapy + chemotherapy visited EDs more times compared with patients receiving only surgeries ($\beta = 0.32$; 95% CI, 0.18 - 0.47 ; $\beta = 0.34$; 95% CI, 0.24 - 0.43 ; $\beta = 0.52$; 95% CI, 0.43 - 0.61 ; $\beta = 0.26$; 95% CI, 0.13 - 0.40 ; $\beta = 0.66$; 95% CI, 0.57 - 0.74). Patients receiving treatment at private hospitals visited EDs fewer times compared with patients receiving treatments at public hospitals ($\beta = -0.11$; 95% CI, -0.15 to 0.06). Patients with more than 1 outpatient visit and treated in a second-level hospital or third-level hospital, rather than a medical center, visited the ED more times. Patients with longer LOS and treated by physicians aged 45 years or more visited the ED fewer times. These differences were all statistically significant ($P < .05$).

DISCUSSION

Our results showed that MDT participants visited EDs fewer times compared with non-MDT participants. Although EDs can provide immediate care to relieve acute symptoms, cancer patients cannot receive proper and

holistic care because EDs, which are frequently crowded and busy, are not satisfactory environments for such care.¹³ In learning that MDT participants use ED care less frequently, indicating that MDT care reduces lung cancer patients' needs to use ED services, we can infer that MDT care improves the quality of cancer patient care.

The most common cause of cancer patients' ED visits is fever (approximately 25%), which differs from the most common cause—pain—identified in previous studies.^{13,15,19} This is possibly because various countries adopt different standards in the timing and methods of prescribing anti-infectives and antipyretic and analgesic medication. Further analysis must be conducted to examine cancer patients' medication dosage and uses. In the 2008 study by Mayer et al,¹³ approximately 7.7% of North Carolina's cancer patients (having all kinds of cancer, and ranging from recently diagnosed to diagnosed years earlier) sought ED care, whereas 57% of the lung cancer patients in this study sought ED care. This is possibly because (a) this study examined the selected cancer patients' ED service uses for the first year after they were diagnosed by physicians, whereas Mayer et al investigated all cancer patients' ED service uses during that year, which resulted in the substantial difference; or (b) the charge of ED service in Taiwan was inexpensive (\$5 to \$15 US) compared with that in the United States.

Male patients use ED services more frequently than female patients, which is consistent with the results of previous studies.^{13,20} Cancer patients with catastrophic illness use ED services more frequently, which is consistent with the findings in the study conducted by Liu et al¹⁶ in 2006. Patients with higher CCI scores have more severe comorbidities and thus use medical services, such as the ED, more frequently. Patients earning higher salaries are less likely to use ED services and use their services less frequently compared with patients earning lower salaries, possibly because the former are more capable of maintaining and enhancing the quality of the daily care they receive and are, therefore, less likely to require ED care. Patients residing in less urbanized areas are more likely to use ED services and to use them more frequently compared with patients residing in more urbanized areas, indicating differing access to medical services based on the residential area's level of urbanization. Patients whose cancer is being treated by surgery alone use ED services less frequently compared with patients receiving other treatments, possibly because they had relatively simple procedures that caused few complications or because they might have been diagnosed relatively early, with less of a chance to develop issues needing ED attention. In addition, lung cancer patients receiving only chemotherapy use ED services less

frequently, although the difference is not statistically significant. Patients receiving treatments at private hospitals and public hospitals do not significantly differ regarding whether they seek ED care. However, patients receiving ongoing treatments at private hospitals visited EDs fewer times compared with patients receiving treatments at public hospitals, possibly reflecting a gap between private and public care quality. As for physicians' characteristics, gender has no effect on patients' ED service uses. In contrast, patients who are treated by senior physicians are less likely to use ED services and use these services less frequently. This could indicate that physicians with more medical experience can reduce their patients' urgent and unpredictable needs regarding receiving medical services.

PSM was employed to reduce the selection bias resulting from varied patients' characteristics in MDT participation. The matching was based on variables including gender, age, monthly salary, urbanization of residence area, CCI scores, catastrophic illness/injury, treatment methods, whether the patient's hospital was public or private, and characteristics of the patient's physician. However, we did not include certain factors that may have affected patients' ED service uses, such as smoking and drinking habits, cancer staging, and type of lung cancer. These data types are difficult to obtain and constitute a limitation of this study. The results only showed the strong potential causation but not the direct evidence.

CONCLUSION

This study found that lung cancer patients who participate in MDT care use ED services less frequently. EDs cannot provide cancer patients with holistic care. Therefore, cancer patients should be provided with MDT care to reduce their need for ED services. In addition, patients participating in MDT care are less likely to have urgent and unpredictable needs for medical care, indicating that MDT care enhances the management of lung cancer patients.

This study found that the primary cause of lung cancer patients' ED visits is fever, which differs from the findings of studies conducted in other countries. Future studies can be conducted to analyze the dosages of anti-infection and antipyretic and analgesic medications that physicians prescribe to lung cancer patients to elucidate the causes of the high frequency of fever in Taiwanese lung cancer patients.

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