ORIGINAL ARTICLE

Quality of Care for Lung Cancer in Taiwan: A Pattern of Care Based on Core Measures in the Taiwan Cancer Database Registry

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Background/Purpose: To investigate the quality of care (QOC) for lung cancer in Taiwan, as measured by pattern of care (POC) variation.

Methods: Based on core measures in the Taiwan Cancer Database (TCDB) registry, QOC for lung cancer was measured as variation in POC for 16 selected core measures for different hospital characteristics. Statistical significance in variation was evaluated by the χ^2 test.

Results: Among the 26 participating hospitals (one excluded as an outlier), 6624 cases of lung cancer were reported in 2004. Among the 16 core measures (6 in the diagnostic and 10 in the therapeutic domain), no significant variation in POC was noted in 12 in northern and non-northern hospitals. However, significant variation in POC was noted for most (5/6) of the core measures in the diagnostic domain for other hospital characteristics (large *vs.* small, medical center *vs.* regional hospital, public *vs.* private). Increasing utilization of tissue diagnosis, diagnostic computed tomography (CT), and CT or magnetic resonance imaging for staging advanced non-small cell lung cancer was noted in the four participating hospitals from 2002 to 2004.

Conclusion: It is very likely that significant variation in QOC for lung cancer in Taiwan exists among different types but not locations of hospitals, at least in the diagnostic domain. The introduction of internal benchmarking (TCDB and core measures) was associated with some changes, at least in some diagnostic domains, which may lead to improvement in QOC for lung cancer in Taiwan. [*J Formos Med Assoc* 2008;107(8):635–643]

Key Words: clinical practice pattern, lung neoplasms, quality of health care, registries

Lung cancer is one of the leading causes of cancer death in Taiwan[1,2] and worldwide,[3] with minimal improvement in its poor survival.[4] In addition to research into innovative treatment modalities, it is important for patients to receive the best standard of care so as to achieve the optimal outcome. However, the ideal scenario that every patient has received optimal treatment does not always come to pass in real clinical practice. Significant variation in the pattern of care (POC) is often observed, and a wide range of adherence to quality measures, from 19% to 100%, has been reported, depending on where the patient lives.[5] For lung cancer, 41–69% of patients with non-small cell

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Table 1. Characteristics of participating hospitals ($n = 27$)

Year	2002	2003	2004
	4	5	27
Location	Northern	Non-northern	
	10	17	
Service volume	Large*	Small	
	8	19	
Level	Medical center	Regional hospital	
	18	9	
Ownership	Public	Private	
	5	22	

**Annual operation number ≥ 34.*

lung cancer (NSCLC, the major histologic type) actually received the recommended therapy in a US population-based study.[6] Similar findings have been reported for some aspects of POC in Asia.[7] The US National Cancer Institute (NCI) has proposed to improve the quality of cancer care by developing core process and outcome measures.[8] In a US annual report based on cancer registries and NCI POC studies, Edwards et al[9] reported a decline in cancer mortality as the dissemination of guideline-based treatment increased. They also found that cancer registries are an important source for monitoring quality of care (QOC). In Taiwan, after approval of the Cancer Prevention and Management Law in 2003, a project was initiated by the Bureau of Health Promotion, Department of Health, and a revised cancer registry (Taiwan Cancer Database; TCDB) was initiated in 2003.[10] In the present study, we investigated the present QOC for lung cancer in Taiwan and the impact of the TCDB, represented by variation in POC,[11] as revealed by the recent TCDB core measure report.[12]

Methods

Patients and hospitals

According to the recent TCDB core measure report,[12] the analyzed patients and hospitals were those that participated in the TCDB project as initiated by the Bureau of Health Promotion, Department of Health. Initially, four hospitals participated in the TCDB for lung cancer in 2002. The number of participating hospitals increased to 27 in 2004, which included all medical centers in Taiwan at the present time.[13] Hospital characteristics (Table 1) were specified, including location, service volume, level (medical center or regional hospital), and ownership (public or private). The geographic location was divided into northern (from Kee-Lung city to Hsin-Chu county) and non-northern regions to ensure adequate hospital numbers within each category. The number of participating hospitals within north, middle, south and east Taiwan was 10, five, 10 and two, respectively. The hospital volume was based on annual operation number. The cut-off point ($n = 34$) was based on a recent endemic study.[14] Hospital level was divided into medical centers and regional hospitals, as evaluated by the Taiwan Department of Health.[13] This study was based on the data reported from these 27 participating hospitals from year 2002 ($n = 4$) to 2003 ($n = 5$) and 2004 ($n = 27$), excluding one big public medical center in north Taiwan as an outlier for its exceptional reported data.

QOC and core measures

QOC evaluation was based on core measure data in association with the TCDB project. The preliminary core measure items were determined by the Delphi method, as previously reported.[15] In view of the feasibility of data retraction, 16 core measures (6 in the diagnostic and 10 in the therapeutic domain) were finalized, as listed in Table 2. For index D1, either cytologic or pathologic examination was considered to be compliant with the core measure. For index D3, either cardiac function or pulmonary testing was considered to be compliant with the core measure. For index D4, execution of at least one systematic work-up (bone scan, computed tomography [CT], magnetic resonance imaging [MRI], positron emission tomography) was considered to be compliant. For indexes T2 and T7, the numerator was based on National Health Insurance (NHI) claim records (code 67010 or 67011). For index T8, the denominator was

Table 2. Selected core measures

Indexes	Notation	Numerator	Denominator
D1	Tissue diagnosis	Those with cytopathologic diagnostic approach	Coded as lung cancer in registry
D2	Chest CT	Those with chest CT at diagnosis	Coded as NSCLC in registry
D3	Preoperative cardiopulmonary evaluation	Those with preoperative cardiac or pulmonary evaluation	Coded as NSCLC receiving operation
D4	Preoperative staging	Those with staging work-up	Coded as NSCLC stage 1–3a receiving operation
D5	Staging in advanced stage: bone scan	Those with bone scan at diagnosis	Coded as NSCLC stage 3b–4
D6	Staging in advanced stage: brain or spine MRI	Those with brain or spine MRI at diagnosis	Coded as NSCLC stage 3b–4
T1	Radical operation for early stage NSCLC	Those receiving radical operation	Coded as NSCLC stage 1–2 receiving operation
T2	Conservative operation for early stage NSCLC	Those receiving conservative operation	Coded as NSCLC stage 1–2 receiving operation
T3	Lymph node dissection or sampling for early stage NSCLC	Those receiving lymph node dissection or sampling	Coded as NSCLC stage 1–2 receiving operation
T4	Adjuvant RT for early NSCLC with positive margin	Those also receiving RT	Coded as NSCLC stage 1–2 receiving operation with positive margin
T5	Chemotherapy or RT for non-operated early NSCLC	Those also receiving RT or chemotherapy	Coded as NSCLC stage 1–2 without operation
T6	Radical operation for stage 3a NSCLC	Those receiving radical operation	Coded as NSCLC stage 3a receiving operation
T7	Conservative operation for stage 3a NSCLC	Those receiving conservative operation	Coded as NSCLC stage 3a receiving receiving operation
T8	Lymph node dissection or sampling for stage 3a NSCLC	Those receiving lymph node dissection or sampling	Coded as NSCLC stage 3a receiving operation
T9	Adjuvant RT for stage 3a NSCLC with positive margin	Those also receiving RT	Coded as NSCLC stage 3a receiving operation with positive margin
T10	Chemotherapy or RT for non-operated stage 3a NSCLC	Those also receiving RT or chemotherapy	Coded as NSCLC stage 3a without operation

CT = computed tomography; NSCLC = non-small-cell lung cancer; MRI = magnetic resonance imaging; RT = radiotherapy.

based on TCDB hospital records. In addition to the above indexes for which multiple core measures were reported, for other indexes, the numerators and denominators were based on the only one reported core measure in the recent TCDB core measure report.[12] As revealed in this report, the measurement was based on TCDB, cancer registry, and claims data from NHI. The POC for each core measure was calculated by summation of the numerator divided by summation of the denominator among different hospital characteristics.

Statistical analysis

POC was expressed as the ratio of patients who received the suggested action among those who were eligible. Patients who had visited different hospitals were counted separately in hospital-specific indexes. Differences between groups were tested by the χ^2 or Fisher's exact test. Time trend was tested by the χ^2 test for trends. For example (see index D2 in Table 3), among 3055 NSCLC patients reported by the 10 hospitals located in northern Taiwan in 2004, 1825 (59.7%) received

Table 3. Pattern of care variation with hospital location

Indexes*	North			Non-northern			*p*
	Events	Total	%	Events	Total	%	
D1	2137	3444	0.620	2195	3580	0.613	0.53
D2	1825	3055	0.597	1850	3185	0.581	0.18
D3	400	451	0.887	371	422	0.879	0.72
D4	285	345	0.826	240	326	0.736	0.005†
D5	1127	2226	0.506	1105	2297	0.481	0.09
D6	1359	2226	0.611	1422	2297	0.619	0.55
T1	195	267	0.730	120	259	0.463	<0.001†
T2	41	267	0.154	49	259	0.189	0.28
T3	262	267	0.981	240	259	0.927	0.003†
T4	4	14	0.286	3	14	0.214	1
T5	32	85	0.376	47	115	0.409	0.65
T6	52	78	0.667	33	67	0.493	0.034†
T7	7	78	0.090	12	67	0.179	0.11
T8	55	56	0.982	38	41	0.927	0.31
T9	4	7	0.571	3	4	0.750	1
T10	65	115	0.565	93	153	0.608	0.48

**Indexes D1–6 and T1–10: see text; †$p<0.05$.*

the recommended CT examination. The corresponding figures were 58.1% (1850/3185) for those 17 hospitals in non-northern Taiwan. The difference was not significantly different (χ^2 test, $p=0.18$). Analyses were conducted using SAS version 9.0 (SAS Institute, Cary, NC, USA) and Egret version 2 (Cytel, Cambridge, MA, USA).

Results

In 2004, 6624 cases of lung cancer were reported by 26 participating hospitals (excluding the one outlier), which may account for 90% of new lung cancer cases in Taiwan, assuming similar lung cancer incidence in 2003 and 2004. There were 7415 cases of lung cancer in Taiwan in 2003, and the data for 2004 are not yet available.[1]

Variation in POC according to hospital location

Among most (12/16) of the indexes, there was no significant variation in POC among northern and non-northern hospitals (Table 3). However, northern hospitals were associated with more preoperative imaging staging work-up (index D4), radical operation for early stage NSCLC (T1), lymph node sampling or dissection for early stage NSCLC (T3), and conservative surgery for stage 3a NSCLC (T6).

Variation in POC according to hospital service volume

Significant variation in POC existed between large- and small-volume hospitals, mainly in the diagnostic domain (5/6) rather than the therapeutic domain (1/10) (Table 4). Large-volume hospitals were associated with more tissue diagnosis (D1), CT (D2) and staging work-up for advanced stage NSCLC (D5 and D6), less preoperative imaging staging (D4), and similar preoperative cardiopulmonary evaluation (D3).

Variation in POC according to hospital level (medical center or regional hospital)

Significant variation in POC existed between medical centers and regional hospitals, mainly in the diagnostic domain (5/6) rather than the therapeutic domain (1/10) (Table 5). Medical centers were associated with more tissue diagnosis

Table 4. Pattern of care variation among large- and small-volume hospitals

Indexes*	Large volume†			Small volume†			*p*
	Events	Total	%	Events	Total	%	
D1	2886	4378	0.659	1446	2646	0.546	<0.001‡
D2	2488	3888	0.640	1187	2352	0.505	<0.001‡
D3	586	662	0.885	185	211	0.877	0.74
D4	393	516	0.762	132	155	0.852	0.02‡
D5	1521	2833	0.537	711	1690	0.421	<0.001‡
D6	1872	2833	0.661	909	1690	0.538	<0.001‡
T1	233	399	0.584	82	127	0.646	0.22
T2	79	399	0.198	11	127	0.087	0.004‡
T3	377	399	0.945	125	127	0.984	0.06
T4	3	15	0.200	4	13	0.308	0.67
T5	44	109	0.404	35	91	0.385	0.78
T6	70	117	0.598	15	28	0.536	0.55
T7	17	117	0.145	2	28	0.071	0.53
T8	77	81	0.951	16	16	1.000	1
T9	3	6	0.500	4	5	0.800	0.55
T10	92	149	0.617	66	119	0.555	0.3

**Indexes D1–6 and T1–10: see text; †cut-off for large and small volume is annual operation ≥34 or not; ‡p<0.05.*

Table 5. Pattern of care variation between medical centers and regional hospitals

Indexes*	Medical centers			Regional hospitals			*p*
	Events	Total	%	Events	Total	%	
D1	3793	5801	0.654	539	1223	0.441	<0.001†
D2	3175	5152	0.616	500	1088	0.460	<0.001†
D3	695	790	0.880	76	83	0.916	0.33
D4	472	612	0.771	53	59	0.898	0.02†
D5	1942	3752	0.518	290	771	0.376	<0.001†
D6	2387	3752	0.636	394	771	0.511	<0.001†
T1	289	477	0.606	26	49	0.531	0.31
T2	84	477	0.176	6	49	0.122	0.34
T3	454	477	0.952	48	49	0.980	0.71
T4	7	26	0.269	0	2	0.000	1
T5	57	159	0.358	22	41	0.537	0.04†
T6	80	135	0.593	5	10	0.500	0.74
T7	17	135	0.126	2	10	0.200	0.62
T8	88	92	0.957	5	5	1.000	1
T9	7	11	0.636	0	0	NA	NA
T10	134	228	0.588	24	40	0.600	0.88

**Indexes D1–6 and T1–10: see text; †p<0.05. NA = not applicable.*

(D1), CT (D2) and staging work-up for advanced stage NSCLC (D5 and D6), less preoperative imaging staging (D4), and similar preoperative cardiopulmonary evaluation (D3).

Variation in POC according to hospital ownership (public or private)

Significant variation in POC existed between public and private hospitals, all in the diagnostic domain

Table 6. Pattern of care variation between public and private hospitals

Indexes*	Public			Private			*p*
	Events	Total	%	Events	Total	%	
D1	1788	2454	0.729	2544	4570	0.557	<0.001†
D2	1642	2166	0.758	2033	4074	0.499	<0.001†
D3	391	436	0.897	380	437	0.870	0.21
D4	293	350	0.837	232	321	0.723	<0.001†
D5	914	1486	0.615	1318	3037	0.434	<0.001†
D6	1153	1486	0.776	1628	3037	0.536	<0.001†
T1	167	276	0.605	148	250	0.592	0.76
T2	59	276	0.214	31	250	0.124	0.006
T3	261	276	0.946	241	250	0.964	0.31
T4	2	8	0.250	5	20	0.250	1
T5	29	68	0.426	50	132	0.379	0.51
T6	45	74	0.608	40	71	0.563	0.59
T7	11	74	0.149	8	71	0.113	0.52
T8	47	50	0.940	46	47	0.979	0.62
T9	3	6	0.500	4	5	0.800	0.55
T10	52	82	0.634	106	186	0.570	0.33

**Indexes D1–6 and T1–10: see text; †p <0.05.*

(5/6) (Table 6). Public hospitals were associated with more tissue diagnosis (D1), CT (D2) and staging work-up for advanced stage NSCLC (D5 and D6), preoperative imaging staging (D4), and similar preoperative cardiopulmonary evaluation (D3).

Variation in POC according to composite hospital types

Because all five public hospitals included in the analysis were also large-volume medical centers, hospitals were further divided into four types (public or private large medical centers, private small medical centers, and private regional hospitals) for further comparison of heterogeneity. Significant variations in POC were noted mainly in the diagnostic domain (5/6) rather than the therapeutic domain (1/10) (Table 7). For tissue diagnosis (D1), CT (D2) and staging work-up for advanced stage NSCLC (D5 and D6), the descending order was public hospitals, followed by small medical centers, large medical centers and regional hospitals. For preoperative imaging staging (D4), the order was regional hospitals, public hospitals, small private medical centers and large private medical centers.

Impact of core measures on the four participants since 2002

Temporal variations in POC for the four participants since 2002 are listed in Table 8. Most (13/16) of the indexes were stable during this period. However, increased utilization of some indexes in the diagnostic domain was noted, which included tissue diagnosis (D1), CT (D2) and staging work-up for advanced stage NSCLC (D6).

Discussion

To the best of our knowledge, this is the first study on QOC for lung cancer in Taiwan based on core measures and cancer registry. We found that there were significant variations in the diagnostic domain between different types of hospital, but less marked differences between hospital locations. There was also some significant increase in utilization of some diagnostic domains after introduction of the TCDB. One of the reasons is that staging information was not available in the prior cancer registry, which hindered the availability of registry-based QOC studies.

Table 7. Pattern of care variation between different kinds of hospitals

Indexes*	Public	Private large medical center	Private small medical center	Private regional	*p*
D1	0.729	0.571	0.637	0.441	<0.001†
D2	0.758	0.491	0.544	0.460	<0.001†
D3	0.897	0.863	0.852	0.916	0.29
D4	0.837	0.602	0.823	0.898	<0.001†
D5	0.615	0.451	0.458	0.376	<0.001†
D6	0.776	0.534	0.560	0.511	<0.001†
T1	0.605	0.537	0.718	0.531	0.06
T2	0.214	0.163	0.064	0.122	0.01†
T3	0.946	0.943	0.987	0.980	0.32
T4	0.250	0.143	0.364	0.000	0.62
T5	0.426	0.366	0.260	0.537	0.054
T6	0.608	0.581	0.556	0.500	0.91
T7	0.149	0.140	0.000	0.200	0.34
T8	0.940	0.968	1.000	1.000	0.76
T9	0.500	NA	0.800	NA	NA
T10	0.634	0.597	0.532	0.600	0.62

**Indexes D1–6 and T1–10: see text; †$p < 0.05$.*

Table 8. Temporal variations in pattern of care among four participants from 2002 to 2004

Indexes*	2002	2003	2004	*p*
D1	0.72	0.72	0.76	0.008†
D2	0.71	0.75	0.76	0.002†
D3	0.92	0.84	0.92	0.89
D4	0.86	0.88	0.91	0.11
D5	0.66	0.69	0.68	0.34
D6	0.72	0.75	0.78	0.003†
T1	0.55	0.44	0.54	0.81
T2	0.24	0.15	0.27	0.51
T3	0.94	0.94	0.97	0.23
T4	0.47	0.5	0.25	0.56
T5	0.45	0.48	0.45	0.99
T6	0.47	0.47	0.61	0.18
T7	0.14	0.16	0.23	0.26
T8	1.00	0.97	0.9	0.07
T9	0.09	0.33	0.5	0.09
T10	0.69	0.67	0.69	0.98

**Indexes D1–6 and T1–10: see text; †$p < 0.05$, χ^2 test for trend.*

However, there are still some shortcomings with the present TCDB and core measures, which are also limitations of the present study. Firstly, small-cell lung cancer was not included in the majority of core measures, although it constitutes only a small proportion (9% in 2003) of all cases of lung cancer.[1] Secondly, in the therapeutic domain, there is a lack of core measures for locally advanced

and advanced NSCLC (73% of NSCLC in TCDB 2004),[12] which is because of a lack of performance status in the present TCDB. Thirdly, the core measures reported so far are all process measures without core outcome measures, which are planned for evaluation in TCDB,[10] but they are not available for the short follow-up period (5 participating hospitals before 2004). Fourthly, the dimensions of the present core measures were limited, mostly focusing on effectiveness instead of other dimensions such as patient-centeredness or timeliness, not to mention other cancer-specific dimensions suggested by the recent American Society of Clinical Oncology (ASCO) and European Society for Medical Oncology (ESMO) consensus statement.[16] However, most of these limitations were caused by difficulty in measurement.

Most of the significant variations we found fell in the diagnostic rather than the therapeutic domain, which may partly be because surgery was infrequently used for lung cancer (16% in cancer registry 2003).[1] Among the 16 core measures used by the present TCDB report, significant variations in the diagnostic domain were noted among hospital types (volume, accreditation level and ownership), which was consistent with a previous systematic review.[17] On the other hand, although geographic variation has been reported in many studies (such as in the recent National Initiative for Cancer Care Quality report),[5] the geographic variations (northern *vs.* non-northern) in the present study were not significant in most (12/16) of these indexes.

We found that POC in Taiwan was consistent with new clinical evidence in a previous study based on registry data from a single institution.[18] We also found increasing compliance with some core measures with increasing years with the TCDB project. A previous systematic review has revealed that outcome is improved with the adoption of clinical practice guidelines.[19] As these core measures were established from evidence-based clinical guidelines,[15] we believe that QOC for lung cancer in Taiwan will be improved in the near future.

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