Utilization of positron-emission tomography under Taiwan's universal health insurance program

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Short running foot line: PET Utilization in Taiwan

ABSTRACT

The National Health Insurance program in Taiwan began covering positron-emission tomography (PET) for selected oncologic indications after imposing global budgets. Delay in acquisition of high-tech equipment, scarcity of high-tech resources and long waiting periods for such services had been reported in a similar universal health care system in Canada. The objective of this study was to assess initial trends of PET utilization in patients with cancer after expansion of coverage under Taiwan's universal health insurance program.

Methods: Using data from the National Health Research Institutes, PET utilization trends were compared at the regional level. The relationships between PET utilization and selected patient and provider characteristics were analyzed using multivariate logistic regression.

Results: Overall, PET utilization rate per million insured increased 51%, from 273 in 2005 to 413 in

2007. In the northern region, the rise in PET utilization was characterized by an increase of 57% in 2006, and a decrease of 7% in 2007, whereas in the central region, there was a decrease of 2% in 2006, and an increase of 62% in 2007. Cancer type, patient age, status of multiple cancers, hospital accreditation level and geographical location were independent factors associated with the likelihood of undergoing PET examination.

Conclusions: PET utilization increased substantially after expansion of insurance coverage in Taiwan. However, PET examinations still accounted for only a small fraction of noninvasive diagnostic imaging studies performed. Although regional levels of PET utilization were commensurate with oncologic burden, there were significant regional variations in the pattern of utilization.

Keywords: Positron-Emission Tomography, Health Care Rationing, Health Insurance, Single-Payer System, Taiwan

INTRODUCTION

18F-Fluoro-2-deoxy-D-glucose (FDG) positron emission tomography (PET) is an advanced medical imaging technology that is increasingly being used in the management of patients with cancer (*1*). It has major impact on the diagnosis and staging, treatment monitoring, restaging and detection of residual or recurrence of certain types of cancer. The rationale underlying the use of FDG-PET in oncology is based on the observation that FDG uptake is substantially higher in most types of cancer compared with its uptake in most normal tissues (*2*,*3*).

Health insurance coverage makes advanced medical technology more accessible to patients who are likely to benefit from these services. Starting in 1998, after review of the evidence of benefit, the Centers for Medicare and Medicaid Service (CMS) began to cover FDG-PET for the evaluation of patients with solitary pulmonary nodules and initial staging of patients with non-small cell lung cancers. This was the first of several steps taken by the CMS toward expansion of FDG-PET reimbursement. In January 2005, CMS established a new approach for expanded coverage of selected evolving technology, such as FDG-PET, as part of a coverage policy called coverage with evidence development (*4*).

In addition to expanding health insurance coverage, advances in medical technology have been implicated as one of the factors leading to escalating health care expenditure (*5*,*6*). Two years after imposing global budgets to control cost, the National Health Insurance (NHI) program in Taiwan began covering FDG-PET for selected oncologic indications in mid 2004. Delay in the acquisition of high-tech equipment, scarcity of high-tech resources and long waiting periods for such services had been reported in a similar universal health care system in Canada (*7*). Little has been published in the literature regarding PET utilization under Taiwan's universal health care system.

In our current study, we analyzed the initial trends of FDG-PET utilization in the management of patients with cancer after expansion of coverage under Taiwan's universal health insurance program.

We used datasets based on the entire population in Taiwan to analyze potential variations in the pattern of utilization of this advanced medical technology in response to expansion of coverage. This empirical assessment of potential variations in resource utilization may provide useful information for future research aimed at improving the quality of care for patients with cancer.

MATERIALS AND METHODS

Data source

We used de-identified claims-related datasets produced for investigational purposes by the National Health Research Institutes (NHRI) from data submitted to the Bureau of National Health Insurance (BNHI). BNHI administers the mandatory universal health insurance program with over 97% coverage of the population in Taiwan. To select patients who underwent PET scanning, we used a file containing a cohort of one million persons randomly selected from the entire insured population of approximately 23 million in 2005. A de-identified version of the registry of patients with catastrophic illness was used to select those with malignancy. For insurance purposes, all types of cancer are classified as catastrophic illnesses. Provider information was obtained from the registry of contracted medical facilities.

Study subjects

We focused on the common cancers that accounted for the vast majority of PET utilization in Taiwan, and found 5,678 patients with head and neck cancers, breast cancer, lung cancer, colorectal cancer, esophageal cancer or lymphoma, who received care at a provider of PET imaging services in the study time frame from 2004 to 2007. Diagnostic codes in the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) were used to identify the status of malignancy, type of cancer, as well as other clinical conditions. The specific codes used for malignancy were: ICD-9-CM 140-149, 160, 161 and 190 for head and neck cancers; ICD-9-CM 174 and 175 for breast cancer; ICD-9-CM 162 for lung cancer; ICD-9-CM 153 and 154 for colorectal cancer; ICD-9-CM 150 for esophageal cancer; ICD-9-CM 200-202 for lymphoma; ICD-9-CM 140-195 and 200-208 for all primary malignancies; ICD-9-CM 196-199 for metastasis. Co-morbidities were identified using the following codes: ICD-9-CM 250 and A-code A181 for diabetes mellitus; ICD-9-CM 401-405 and A-codes A260-269 for hypertension with or without complications. A-codes were used, in conjunction with the ICD-9-CM codes, to identify chronic co-morbidities, because these conditions were coded in the past with A-codes before the adoption of ICD-9-CM.

Statistical analysis

Descriptive statistics regarding cancer type, hospital accreditation level and organizational type, were presented by geographical location. We compared the utilization of PET with that of other noninvasive diagnostic imaging, such as MRI, CT and ultrasound imaging, in the select patient population. We also compared various patient and provider characteristics between patients who underwent PET scanning and those who did not. In addition to cancer type, we attempted to analyze other clinical factors, including stage or extent of cancer, and status of multiple cancers and co-morbidities. The Chi-square test or Fisher test was used, as appropriate, to test for statistical significance. A multivariate logistic regression model was used to evaluate the relationship between the likelihood of undergoing PET scanning and selected patient and provider characteristics. The statistical tool used was SAS software version 9.1 (SAS Institute Inc., Carey, NC). Statistical significance was defined at the conventional level of 0.05 in a two-tailed test.

RESULTS

In the period from 2004 to 2007, 40 facilities provided PET imaging services to the select oncologic population (Table 1). Fourteen of these were located in the northern region, 12 each in both the central and southern regions, and 2 in the eastern region. The majority of the northern facilities (8/14) were medical centers, while most of the facilities in the central and southern regions were not. Most of the facilities operated as non-profit organizations, except for those in the central region, where half (6/12) were for-profit organizations.

The common cancers in the select patient population were, in descending order of frequency, breast cancer, colorectal cancer, head and neck cancers, non-small cell lung cancer, lymphoma and esophageal cancer, accounting for 31%, 26%, 20%, 15%, 5% and 3% of the select oncologic population, respectively (Table 2). The northern region had the majority (55%) of the select oncologic population, followed by the central (22%), southern (18%) and eastern (5%) regions. The northern region had disproportionately more patients with breast and colorectal cancers, whereas the southern region had disproportionately more patients with head and neck cancers and non-small cell lung cancer.

Four types of cancer accounted for the vast majority (84%) of oncologic FDG-PET scans, with head and neck cancers, colorectal cancer, non-small cell lung cancer and breast cancer accounting for 25%, 21%, 20% and 18% of total scan volume, respectively. More than one third (36%) of the scans performed in the southern region were for head and neck cancers.

Eleven percent of the select oncologic population who received care at a provider of PET imaging services underwent FDG-PET examination. Esophageal cancer and lymphoma had high scan rates of 22% and 20%, respectively, whereas breast cancer had a low scan rate of 7%. The northern region had the lowest scan rate for breast cancer (5%). Approximately one fifth (21%) of all oncologic FDG-PET scans were repeat scans. The most common cancer to undergo repeat FDG-PET examination was lymphoma. Thirty percent of patients with lymphoma who had one FDG-PET scan underwent repeat scans.

On univariate analysis, certain patient and provider characteristics were associated with higher utilization (Table 3). For non-small cell lung cancer, these included patients younger than 65 years of age, those with higher income or multiple cancers, and those who received care at an eastern facility, or at a regional or district hospital. Younger patients with colorectal cancer were also more likely to undergo PET scanning. Regardless of cancer type, patients who received care at regional or district hospitals were more likely to undergo PET examination, compared with those who received care at or were referred to medical centers.

On multivariate logistic regression, some of these relationships remained statistically significant (Table 4). Cancer type strongly influenced the likelihood of undergoing PET examination--patients with esophageal cancer were more likely to be scanned, compared with those with breast cancer. Patient age, status of multiple cancers and hospital accreditation level were independent factors associated with the likelihood of undergoing PET scan. The same was true for geographical location--patients who received care at eastern facilities were more likely to be scanned, compared with those in the northern region.

Overall, the number of PET scans per million insured persons increased from 273 in 2005 to 378 in 2006 and to 413 in 2007—a 51% increase over two years (Figure 1). Even with this increase, PET utilization represented only 4% of the number of noninvasive imaging studies performed, including MRI, CT and ultrasound imaging. In the northern region, the rise in PET utilization was characterized by a 57% increase in 2006, followed by a 7% decrease in 2007. There was a delayed surge in the central region with a 2% decrease in 2006, and a 62% increase in 2007. The pace of rising utilization in the southern region fell in between those of the northern and central regions, with consecutive yearly increases of 36% and 17% in 2006 and 2007, respectively.

TABLE 1. Count of providers by accreditation level, organizational type and geographical region

Geographical region	Northern N=14		Central N=12		Southern N=12		Eastern N=2		Total N=40	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Accreditation level										
Medical center	8	(57.1)	4	(33.3)	5	(41.7)	1	(50.0)	18	(45.0)
Regional hospital	5	(35.7)	5	(41.7)	7	(58.3)	1	(50.0)	18	(45.0)
District hospital	1	(7.1)	3	(25.0)	0	(0.0)	0	(0.0)	4	(10.0)
Organizational type										
Public	4	(28.6)	1	(8.3)	2	(16.7)	0	(0.0)	7	(17.5)
Non-profit	10	(71.4)	5	(41.7)	8	(66.7)	2	(100.0)	25	(62.5)
For-profit	0	(0.0)	6	(50.0)	2	(16.7)	0	(0.0)	8	(20.0)

TABLE 2. Frequency of selected cancers by geographical region

Geographical region	Northern N=4,585		Central N=1,843		Southern N=1,605		Eastern N=488		Total N=7,791	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Type of cancer										
Head & neck cancers	742	(48.6)	334	(21.9)	364	(23.9)	86	(5.6)	1,526	(100)
Breast cancer	1,402	(58.0)	508	(21.0)	399	(16.5)	107	(4.4)	2,416	(100)
Colorectal cancer	1,209	(59.1)	454	(22.2)	272	(13.3)	110	(5.4)	2,045	(100)
Esophageal cancer	105	(50.0)	49	(23.3)	38	(18.1)	18	(8.6)	210	(100)
NSC lung cancer *	547	(46.9)	287	(24.6)	256	(22.0)	76	(6.5)	1,166	(100)
Lymphoma	245	(57.2)	97	(22.7)	67	(15.7)	19	(4.4)	428	(100)

* NSC lung cancer indicates non-small cell lung cancer.

TABLE 3. Univariate analysis of patient and provider characteristics by cancer type between patients with and without PET examination

Cancer type	Head & neck cancers					Breast cancer					Colorectal caner					Esophageal cancer					NSC lung cancer *					Lymphoma				
PET scanned	No		Yes			No		Yes			No		Yes			No		Yes			No		Yes			No		Yes		
	n	%	n	%	p	n	%	n	%	p	n	%	n	%	p	n	%	n	%	p	n	%	n	%	p	n	%	n	%	p
All	1,050	87	156	13		1,666	93	117	7		1,184	90	135	10		123	78	35	22		740	86	124	14		279	80	69	20	
Patient characteristics																														
Gender					0.21					1					0.83					0.16					0.09					0.7
Female	213	20	25	16		1,660	100	117	100		497	42	58	43		8	6	5	14		263	35	54	44		108	39	25	36	
Male	837	80	131	84		6	0	0	0		687	58	77	57		115	94	30	86		477	65	70	56		171	61	44	64	
Age (years)					0.3					0.69					0.003					0.55					0					0.18
< 55	535	51	85	54		984	59	69	59		360	22	29	21		44	36	12	34		115	15	30	24		119	43	38	55	
55 - 64	246	23	40	26		397	24	31	27		233	20	43	32		28	23	11	32		152	21	35	28		51	18	10	15	
≥ 65	269	26	31	20		285	17	17	14		691	58	63	47		51	41	12	34		473	64	59	48		109	39	21	30	
Income †					0.28					0.94					0.51					0.27					0.03					0.96
< 10,000	405	39	54	35		714	43	52	45		633	54	77	57		51	41	17	49		411	56	58	47		153	55	37	54	
10,000-19,999	340	32	47	30		379	23	26	22		309	26	29	21		53	43	10	28		209	28	34	27		76	27	20	29	
≥ 20,000	305	29	55	35		573	34	39	33		242	20	29	22		19	16	8	23		120	16	32	26		50	18	12	17	
Region					0.49					0.01					0.36					0.19					0.01					0.95
Northern	556	53	73	47		1,027	61	56	48		755	63	87	64		59	48	21	60		378	51	70	57		168	60	42	61	
Central	228	22	37	24		344	21	30	26		247	21	23	17		34	28	6	17		182	25	25	20		59	21	14	20	
Southern	217	21	39	25		234	14	21	18		125	11	20	15		21	17	3	9		144	19	15	12		40	14	9	13	
Eastern	48	4	7	4		61	4	10	8		57	5	5	4		9	7	5	14		36	5	14	11		12	5	4	6	

* NSC lung cancer indicates non-small cell lung cancer.

† Income indicates monthly income in Taiwan New Dollars (TWD). One US Dollar is currently worth approximately 32 TWD.

TABLE 3 (continued). Univariate analysis of patient and provider characteristics by cancer type between patients with and without PET examination

Cancer type	Head & neck cancers					Breast cancer					Colorectal caner					Esophageal cancer					NSC lung cancer					Lymphoma				
PET scanned	No		Yes			No		Yes			No		Yes			No		Yes			No		Yes			No		Yes		
	n	%	n	%	p	n	%	n	%	p	n	%	n	%	p	n	%	n	%	p	n	%	n	%	p	n	%	n	%	p
Clinical features																														
Metastasis					0.45					0.66					1					0.52					0.88					1
No	1,037	99	153	98		1,657	99	116	99		1,175	99	134	99		104	85	28	80		733	99	123	99		276	99	69	100	
Yes	13	1	3	2		9.0	1	1.0	1		9.0	1	1.0	1		19	15	7	20		7	1	1	1		3	1	0	0	
Multiple cancers					0.41					0.02					0.87					1					0					0.96
No	926	88	134	86		1,600	96	107	91		1,020	86	117	87		121	98	35	100		681	92	104	84		215	77	53	77	
Yes	124	12	22	14		66	4	10	9		164	14	18	13		2	2	0	0		59	8	20	16		64	23	16	23	
Comorbidities					0.53					0.50					0.97					0.24					0.94					0.35
No	660	63	94	60		1,073	64	79	67		524	44	60	44		70	57	16	46		260	35	44	35		169	61	46	67	
Yes	390	67	62	40		593	36	38	33		660	56	75	56		53	43	19	54		480	65	80	65		110	39	23	33	
Accreditation level					<0.0001					0.0004					<0.0001					0.22					<0.0001					<0.0001
Medical center	896	85	113	72		1,316	79	76	65		993	84	89	66		111	90	29	83		629	85	85	69		239	86	43	62	
Non-medical ctr.	154	15	43	28		350	21	41	35		191	16	46	34		12	10	6	17		111	15	39	31		40	14	26	38	
Organizational type					<0.0001					0.0005					0.67					0.93					0.19					0.31
Public	544	52	48	30		641	38	34	29		459	39	48	36		59	48	18	51		362	49	51	41		136	49	32	46	
Non-profit	493	47	107	69		994	60	75	64		691	58	84	62		61	50	17	49		369	50	70	57		135	48	37	54	
For-profit	13	1	1	1		31	2	8	7		34	3	3	2		3	2	0	0		9	1	3	2		8	3	0	0	

TABLE 4. Multivariate logistic regression of the likelihood of undergoing PET scan

Independent variables	Odds ratio	(95% CI) *
Patient characteristics		
Male gender (vs. Female)	1.02	(0.82-1.25)
Age, year (vs. ≥ 65)		
< 55	1.51	(1.20-1.90)
55 - 64	1.64	(1.30-2.08)
Income (vs. ≥ 20,000) †		
< 10,000	1.03	(0.83-1.29)
10,000 - 19,999	0.86	(0.67-1.10)
Region (vs. Northern)		
Central	1.10	(0.88-1.39)
Southern	0.95	(0.74-1.23)
Eastern	1.68	(1.18-2.38)
Clinical features		
Multiple cancers (vs. One cancer only)	1.42	(1.11-1.82)
Cancer type (vs. Breast cancer)		
Head & neck cancers	2.29	(1.69-3.11)
Colorectal cancer	1.93	(1.43-2.59)
Esophageal cancer	4.89	(3.05-7.83)
Non-small cell lung cancer	2.96	(2.17-4.03)
Lymphoma	3.79	(2.65-5.43)
Provider characteristics		
Accreditation level (vs. Medical center)		
Regional/District hospital	2.56	(2.05-3.21)
Organizational type (vs. Public)		
Non-profit	1.05	(0.86-1.29)
For-profit	0.63	(0.33-1.20)

* 95% CI indicates 95% confidence interval.

† Income indicates monthly income in Taiwan New Dollars (TWD). One US Dollar is currently worth approximately 32 TWD.

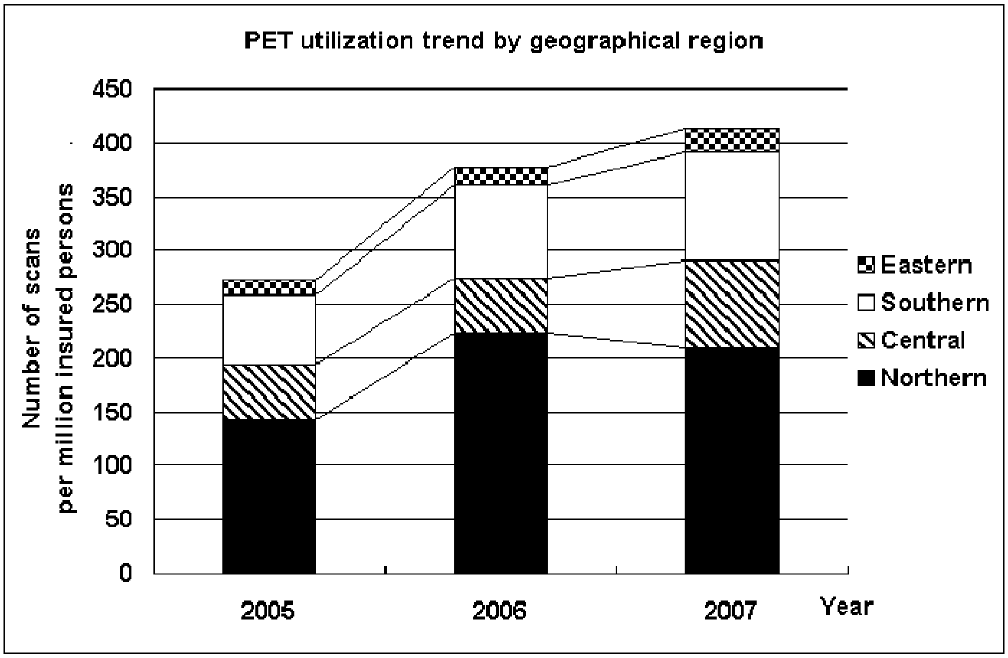

FIGURE 1. PET utilization trend by geographical region in Taiwan

DISCUSSION

In our current study, we analyzed the initial trends of FDG-PET utilization in the management of patients with cancer after expansion of coverage under Taiwan's universal health insurance program. The National Health Insurance (NHI) program is a government-run, single-payer entity administered by the Bureau of National Health Insurance (BNHI), and compensates a mixed public and private delivery system predominantly on a fee-for-service basis (*8*). The program provides coverage for a wide range of services, including primary care services, ambulatory and inpatient care, prescription and certain over-the-counter drugs, as well as protection from catastrophic medical costs. NHI classifies all types of cancer as catastrophic illnesses, and reimburses all medical services related to cancer care, including diagnostic work-up, established treatment and management of potential complications. Due to compulsory enrollment, NHI has maintained an overall coverage of over 97% of the population in Taiwan since its inception in 1995 (*9*).

More than 90% of Taiwan's healthcare providers contract with the BNHI to offer services covered by NHI, which allows the insured complete freedom of choice among providers. In 2004, the Taiwan Joint Commission on Hospital Accreditation certified 17 of Taiwan's top medical institutions as medical centers, and among a total of 516 hospitals that passed accreditation, 67 were certified as regional teaching hospitals (*10*). The claims records show that all medical centers and a minority of the regional teaching hospitals (18/67) provided PET imaging services to patients with cancer.

NHI began covering FDG-PET examinations for selected oncologic indications in mid 2004. These indications include staging and therapeutic response monitoring of breast cancer; diagnosis and staging of colorectal cancer, head and neck cancers (excluding brain tumor and primary thyroid cancer), non-small cell lung cancer, lymphoma, esophageal cancer and melanoma; differential diagnosis of single pulmonary nodules (suspected lung cancer); and restaging of recurrent thyroid cancer. Compared with Western countries, Taiwan is notable for its relatively high prevalence of head and neck cancers, especially in southern Taiwan. In the current study, the data show that head and neck cancers accounted for one quarter of the oncologic PET examinations covered by NHI overall, and more than one third (36%) of those performed in the southern region.

Prior research found strong empirical evidence of an association between third-party payment program and increased likelihood of adoption and use of advanced medical technology (*11*). The current study provides empirical evidence of the association between NHI coverage and increased PET utilization in patients with cancer. The data indicate that the oncologic PET utilization rate per million insured increased from 273 in 2005 to 378 in 2006 and to 413 in 2007—a 51% increase over the two-year period. This level of increase cannot be fully explained by changes in the incidence rates of the selected cancers over the same time frame. Even with this increase, PET utilization represented only 4% of the number of noninvasive imaging studies performed, including MRI, CT and ultrasound imaging.

Although the total increase in utilization from 2005 to 2007 was comparable among the various regions in Taiwan, there were significant regional differences in the rapidity of response to expanded insurance coverage. The surge in oncologic PET utilization occurred most rapidly in the northern region, with a rise of 57% in 2006, followed by a slight decrease of 7% in 2007. In contrast, the pace of increase in the southern region was more moderate, with consecutive yearly increases of 36% and 17% in 2006 and 2007, respectively, whereas the central region had a slight decrease of 2% in 2006, followed by a delayed surge of 62% in 2007. The data suggest that the northern region had the essential elements enabling it to respond promptly and vigorously to the expanded coverage. It had not only the major portion of Taiwan’s oncologic burden, in terms of patient population, but also the largest number of providers, most of which were accredited as medical centers.

In the central region, there was a substantial increase in the number of PET imaging system installations in 2007, as four separate regional hospitals, previously without this technology, jumped on the bandwagon to join the medical centers in providing this service. A new installation was also added at one of the four medical centers in the region, all of which were already equipped with PET imaging technology. These new installations conspicuously coincided with the regional surge of PET utilization in the same year.

In our current study, various patient and provider characteristics are associated with the likelihood of undergoing PET examination. The strong influence of cancer type on the likelihood of undergoing the scan is to be expected, since the examination may serve different roles in different cancers. Patient age and status of multiple cancers are also independent factors associated with the likelihood of undergoing the scan. These associations are reasonable since younger patients and those with multiple cancers may more likely benefit from this examination. Alternatively, the association between the likelihood of undergoing the scan and status of multiple cancers may be due to the potential of the scan to uncover synchronous malignancies. Although FDG-PET is known for its superiority in detecting distant metastases (*12*), we were unable to show a statistically significant relationship between stage of cancer and the likelihood of undergoing PET scan using the claims data. This may be due to inherent inadequacies in the source data, in terms of coding for the extent of the disease.

While associations between patient or clinical characteristics and the likelihood of undergoing PET scan may have plausible explanations, apparent relationships between provider characteristics and the likelihood of undergoing the scan may not have easily recognizable explanations from a clinical perspective. The data indicate that patients who received care at regional or district hospitals are more likely to undergo PET examination, compared with those who received care at or were referred to medical centers. The same is true for patients who received care at eastern facilities, compared to those who received care at northern facilities. While these relationships may not have simple explanations, it is worth noting that regional and district hospitals, as well as eastern facilities, serve only a small minority of the select patient population.

A report estimated the number of dedicated PET scanners required to support the demand for PET studies to be 0.82 per million population (2,026 scans per million population per year) for all oncologic indications in the United Kingdom (*13*). The estimates were based on a model calculating the number of dedicated PET scanners required to support the demand for PET studies in lung cancer. This was then extended to all oncologic indications for PET. The number of PET scans required for lung cancer was calculated using lung cancer incidence rates and a decision tree (clinical algorithm), and was estimated to be 29,886 per year in UK with 38,070 new cases per year, 82% of which were estimated to be non-small cell lung cancer.

In our analysis, the data indicate that the number of PET scans reimbursed by NHI for lung cancer in Taiwan in 2007 was approximately one fifth of the estimated level required, using the UK algorithm adjusted for Taiwan's lung cancer incidence rates. Although our study does not account for PET scans not reimbursed by NHI, the records in the claims database likely reflect the vast majority of all PET examinations performed for the selected oncologic indications. The seemingly low level of utilization for lung cancer may reflect differences in determinations of cost-effectiveness between disparate health systems. Other important factors influencing the level of utilization may include cost control measures, such as the imposition of global budgets before insurance coverage expansion. Although global budgets do not necessarily control the quantity of service provided, these constraints may limit the number of PET scans performed due to significant incremental cost of performing this examination. More direct means of utilization control take the form of quotas, in terms of the number of examinations allowed in a certain time frame. Preferences of patients and referring physicians may also affect utilization level.

The results of our study depend on the quality of the claims datasets managed by NHRI, and are limited by the accuracy and completeness of the data submitted to BNHI. Our current study does not account for the stage of cancer, due to evidence of inadequate coding of the extent of cancer in the datasets used. The addition of adequately coded staging information may affect the results of our study. Since our study is based on a sample of the full claims database, there is a small chance that a repeat analysis of the claims data, using a different sample dataset or the full database, will produce different results. Our study does not provide evidence regarding the cost-effectiveness or potential benefits, in terms of improved clinical outcomes, that may be attributable to the adoption of this advanced medical imaging technology.

CONCLUSION

PET utilization increased substantially after expansion of insurance coverage in Taiwan. However, PET examinations still accounted for only a small fraction of noninvasive diagnostic imaging studies performed. Although regional levels of PET utilization were commensurate with oncologic burden, there were significant regional variations in the pattern of utilization.

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