ACCURACY OF DIABETES DIAGNOSIS IN HEALTH INSURANCE CLAIMS DATA IN TAIWAN

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Background and Purpose: There are limited data from Taiwan about the accuracy of National Health Insurance (NHI) claims data. This study assessed the accuracy of NHI claims data for diabetes and its associated factors.

Methods: Insurance claims data for patients with a diagnosis of diabetes were extracted from the records of the Bureau of National Health Insurance, including detailed files of the outpatient, emergency, inpatient and pharmacy treatment records from January 1, 2000 to December 31, 2000. A stratified, 2-staged, probability proportional to size and equal probability method was used to sample 9000 diabetes patients. The accuracy of the diabetes diagnosis was assessed based on patient responses to questionaire items. Subjects with negative or uncertain questionaire answers who had hypoglycemic agents in pharmacy claims data were also classified as diabetic.

Results: A total of 1350 questionnaires were returned and an accurate diagnosis was verified from data in 1007 (74.6%) of these subjects. Univariate analysis showed that level of accreditation of the hospital, age, gender, follow-up department, type of complication, number of outpatient visits, emergent visit, as well as hospitalization were significant factors associated with an accurate diagnosis of diabetes. Multivariate logistic regression analysis revealed that number of outpatient visits, hospitalization, age, and the level of accreditation of the hospital were significant independent factors. The odds ratio of an accurate diagnosis increased with the number of outpatient visits and hospitalization. The probability of accurate diagnosis of diabetes among patients with ≥ 4 outpatient visits was 99.16 times greater than that of patients with ≤ 1 outpatient visit. The probability of accurate diagnosis in patients with ≥ 1 hospitalization was 5.26 times that of patients who had not been hospitalized.

Conclusions: This study found that the accuracy of diabetes diagnosis in NHI claims data in Taiwan was 74.6%. Further attention to the association of inaccurate claims in cases with infrequent outpatient visits, young age and those attending non-accredited hospitals is needed in order to address the efficiency of diagnosis and surveillance of diabetes in Taiwan.

Key words: Diabetes; Health surveys; Insurance claim reporting; National health programs; Population surveillance

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Insurance claims data have been increasingly adopted in research and evaluation of areas including epidemiology, health care, quality of care, cost and utilization studies, and health care policy.[1–4] These data present several advantages for researchers as they provide population-based longitudinal records of patient care.[5,6] Research using insurance claims data is unobstructive to patients and providers and unaffected by measurement errors introduced by poor patient recall. In addition, these data can identify many cases over a short period of time. Follow-up of patients is possible with less effort and expense than that required in clinical series or trials. Moreover, data collection costs are minimized due to their availablity on computer databases.[7,8]

However, the suitability of insurance claims data for clinical use in research is also limited due to the level of clinical details encoded by the International Classification of Diseases (ICD) coding system and the recorded codes system required in reporting insurance claims.[9,10] Problems related to coding accuracy and financial incentives may also lead to bias in coding.

Previous analyses of claims data accuracy for case identification centered on the major categories of surgical procedure,[11] cancer,[12] depression[13,14] and chronic diseases[15–17] such as hypertension[18,19] and diabetes.[20–22] The accuracy rate of insurance claims data in these studies was found to range from approximately 61-90%. The accuracy of insurance claims data is associated with disease types and clinical conditions.

Various medical conditions, such as hip fracture, acute myocardial infarction, and some types of cancers are more likely to be accurately coded as such coding is needed to cover virtually all major surgical procedures. However, numerous clinical conditions are coded with limited accuracy.[15] A previous study suggested that the accuracy rates of disease-specific claims data may increase to 96% if the claims data are modified by valid methods.[18]

Three major standards were set to test the accuracy of claims data in previous studies: clinical medical records,[11,12,15–17,20] face-to-face interview,[19] and patients' self-reporting from a mailed questionaire.[13,14,18,21,22] Although the method of patients' self-reporting from a mailed questionaire is simpler and more inexpensive than the others, the reponse rate of this method is the lowest of these 3 methods, while the validity of these 3 methods is almost equal.[19,23–26] Previous studies showed that self-reported chronic disease status was a valid method of diagnosing diabetes compared with medical records and physician information.[23–26]

Data on the accuracy rate of insurance claims data in Taiwan are limited. This study assessed the accuracy of insurance claims data for diabetes and examined factors associated with this accuracy.

Methods

Insurance claims data

In Taiwan, 96.3% of residents were insured for National Health Insurance (NHI) at the end of 1999 and 91.7% of hospitals and clinics in this country participated in the NHI program. During the 1-year study period in 2000, Taiwan had 22,184,530 citizens and the total number of clinic visits for diabetes was 27,790,867, equal to 10.87% of the total outpatient visits (255,761,465). The total number of hospitalizations for diabetes was 428,291, equal to 15.15% of total hospitalizations (2,826,569) in the same year.

Claims data from the Bureau of National Health Insurance (BNHI) were used in this study, including all detailed files of outpatients, emergency visits, inpatient prescriptions and treatment records during the period from January 1, 2000 to December 31, 2000. Data were obtained from the files maintained for every Taiwanese citizen with an assigned identification number. Patients with a documented diagnosis of diabetes were classified as indicated by the presence of a diabetes-specific ICD ninth revision, clinical modification (ICD-9-CM) code for diabetes and complications (250.00-250.93), for neonatal diabetes (775.1) and ICD-9 A code for diabetes (A181). Claims with any codes were classified as diabetes. Uncertain cases with codes of diabetes in pregnancy (648.0),

abnormal glucose tolerance in pregnancy (648.8), abnormal glucose tolerance test (790.2), glycosuria (791.5), and acetonuria (791.6) were excluded from this study, while 895,848 cases with a documented diagnosis of diabetes were included and defined as the target population.

Factors associated with the accuracy of diabetes insurance claims data were classified into provision of medical service or profile of patient categories. Provision of medical service included the location of medical institutions (divided by governing branch of the Bureau of the NHI into 6 categories: Taipei, Northern, Middle, Southern, Kao-Ping, and Eastern branch bureaus), type of organization (3 categories: public, private for profit, and private non-profit), follow-up department (5 categories: endocrinology and metabolism, medicine, family medicine, general practitioner [GP], and others), and the level of accreditation of the hospital (4 categories: medical center, regional hospital, district hospital, local clinic and others); and profile of patients included age (3 categories: ≤ 40, 40-50, ≥ 50 years), gender (male and female), number of complications (2 categories: no complication and 1 or more complications), number of outpatient visits (4 categories: ≤ 1, 2, 3, and ≥ 4 times), number of emergent visits (2 categories: 0 and ≥ 1 times), and number of hospitalizations (2 categories: 0 and ≤ 1 times). The category to which each factor belonged was defined according to the highest frequency of visiting a specific department, organization, or hospital for follow-up in 2000. For example, a diabetes patient was classified as treated in the division of endocrinology and metabolism if the patient visited the division of endocrinology and metabolism 3 times, the family medicine department twice, and a GP once.

Types of complications were determined according to the diagnostic codes. The ICD-9-CM codes for diabetic complications included ketoacidosis (250.1x), hyperosmolarity (250.2x), diabetes with coma (250.3x), renal manifestations (250.4x), ophthalmic manifestations (250.5x), neurologic manifestations (250.6x), peripheral circulatory disorders (250.7x), other specified manifestations (250.8x) and unspecified complication (250.9x). The number of outpatient and emergency visits due to diabetes was also calculated. However, the number of hospitalizations was counted based on the frequency of visits to hospitals which recorded any diagnosis code for diabetes.

Patient survey

According to previous studies,[15,20] we estimate the accuracy of data from insurance claims for diabetes in Taiwan to be around 70-80%, with a deviation of 3%

producing an estimated sample size of 683-896 persons. If the response rate of the questionnaire by mailing was assumed to be 10-20%, 9000 patients would therefore be required to be included in the sample. Subjects were screened by using a stratified, 2-stage (living area and diabetes), probability proportional to size (PPS), and equal-probability method. First, 7756 villages in Taiwan were screened and divided into 4 quantile groups using a stratified, PPS method based on the prevalence rate of diabetes in each village. 387 villages were sampled from the 4 groups and 9000 subjects were extracted using the equal-probability method.

The questionnaire included the following 5 items: 1) Have doctors ever told you that you have diabetes, high blood sugar, or sugar in your urine (exclusive of pregnancy)? 2) Have you ever taken an oral hypoglycemic agent? 3) Have you ever used an insulin injection? 4) Have you had an examination for blood sugar during the year 2000? 5) What was/were the result(s) of the blood sugar test(s)? The possible answers were positive, negative and uncertain. Patients were classified as diabetic if they gave any affirmative response to the first 3 items of the questionnaire. In addition, subjects with a negative or uncertain response to these 3 questions who had hypoglycemic agents in pharmacy claims data were also classified as diabetic. In this study, the hypoglycemic agents considered included 6 major types of agents: insulin, sulfonylureas, biguanides, α-glucosidase, thiazolidinediones, and meglitinides.

Statistical analysis

Data were processed using SAS statistical software version 8.0. Descriptive statistics was used to the patterns of basic variables, including mean, standard deviation, and percentage. Chi-squared test was applied to compare relationships between the study population and the sampled population with regard to gender, location, type of organization, where treatment was given, follow-up department, the level of accreditation of the hospital, complications and number of outpatient visits, emergent visits, and hospitalizations. *t* test was used to determine how the study population and the study sample differed in age. Univariate and multivariate logistic regression analyses were employed to analyze factors associated with accuracy of NHI claims data. A *p* value < 0.05 was considered statistically significant.

Results

Among the 9000 questionaires mailed to patients, 1350 were completed and returned, and these subjects were defined as the study sample. There were 955 subjects whose diabetes diagnosis was verified, 326 whose diagnosis was classified as incorrect and 69 whose diagnosis was classified as uncertain. Among the cases with negative/uncertain answers on the survey, 27/25 had hypoglycemic agents in pharmacy claims data. A final total of 1007 diabetes cases and 343 non-diabetes cases were classified from the study sample, resulting in an estimate of the accuracy of diabetes insurance claims data of 74.6%. Table 1 shows the comparison between the survey population and the study sample.

Univariate analysis indicated that the accuracy of diabetes diagnosis on claims data increased with the level of accreditation of the hospital, age, number of complications, number of outpatient visits, emergent visits, and hospitalization. The diagnostic accuracy for males was greater than that for females and the accuracy for patients treated in the division of endocrinology and metabolism exceeded those treated in medicine, family medicine, GP and others (Table 2).

Multivariate logistic regression analysis indicated that number of outpatient visits, number of hospitalizations, age of the patient and the level of accreditation of the hospital were significant independent factors associated with diagnostic accuracy. The odds ratio of accurate diagnosis increased with the number of outpatient visits and with hospitalization. The probability of correct diagnosis of diabetes for patients with > 4 outpatient visits was 99.16 times that of those with < 1 outpatient visit. The probability of accurate diagnosis in patients with > 1 hospitalization was 5.26 times that of patients who were never hospitalized. The probability of a correct diagnosis of diabetes in a patient treated at a medical center was 0.62 times that of a patient treated in a district hospital (Table 3).

Discussion

This study found that the accuracy of diabetes insurance claims data in Taiwan was 74.6%. This result is similar to the diagnostic accuracy for diabetes reported in a previous study from Ontario (61%)[20] and from US Medicare data (65.7% and 88.2%).[15] These data suggest that the rates of overdiagnosis are similar in numerous countries.

Patients with ICD-9-CM diagnosis codes of 250.00-250.93, 775.1 and A181 are usually receiving treatment for diabetes. However, in this study, patients with these codes who had ≤ 1 outpatient visit in 1 year had a diagnostic accuracy of only 21.2% although they accounted for over one-quarter of annual total claims

Table 1. Comparison of characteristics of the survey population and the study sample.

	Survey population (n = 9000) No. (%)	Study sample (n = 1350) No. (%)	p value
Age (years)	59.6 ± 14.4	61.2 ± 13.3	< 0.01
Male	4269 (47.4)	734 (54.4)	< 0.01
Number of outpatient visits			
Average	8.4	9.9	< 0.01
≤ 1	2463 (27.4)	297 (22.0)	
2	680 (7.6)	77 (5.7)	
3	402 (4.5)	53 (3.9)	
≥ 4	5455 (60.6)	923 (68.4)	
Number of emergent visits			
Average	0.10	0.07	< 0.01
0	8372 (93.0)	1288 (95.4)	
≥ 1	628 (7.0)	62 (4.6)	
Number of hospitalizations			
Average	0.27	0.18	< 0.01
0	7477 (83.1)	1179 (87.3)	
≥ 1	1523 (16.9)	171 (12.7)	
Number of complications			0.14
0	6729 (74.8)	984 (72.9)	
≥ 1	2271 (25.2)	366 (27.1)	
Location of medical institution where treatment was received			< 0.01
Taipei branch bureau	2729 (30.3)	469 (34.7)	
Northern branch bureau	1158 (12.9)	177 (13.1)	
Middle branch bureau	1590 (17.7)	223 (16.5)	
Southern branch bureau	1677 (18.6)	241 (17.9)	
Kao-Ping branch bureau	1584 (17.6)	209 (15.5)	
Eastern branch bureau	262 (2.9)	31 (2.3)	
Level of accreditation of the hospital at which treatment was received		0.50	
Medical center	1869 (20.8)	311 (23.0)	
Regional hospital	2054 (22.8)	291 (21.6)	
District hospital	2154 (23.9)	339 (25.1)	
Local clinic and others	2923 (32.5)	409 (30.3)	
Organization type			0.04
Public	3307 (36.7)	654 (48.4)	
Private for profit	3842 (42.7)	467 (34.6)	
Private non-profit	1851 (20.6)	229 (17.0)	
Follow-up department			< 0.01
Endocrinology and Metabolism	1454 (16.2)	287 (21.3)	
Medicine	4021 (44.7)	596 (44.2)	
Family medicine	1304 (14.5)	195 (14.4)	
General practitoner	1145 (12.7)	126 (9.3)	
Others	1076 (12.0)	146 (10.8)	
Oral hypoglycemic agents and insulin use			< 0.01
Yes	5565 (61.8)	916 (67.8)	
No	3435 (38.2)	434 (32.2)	

data for diabetes (27.4%). The accuracy of cases with only 2 outpatient visits was only 36.4% and that of patients with 3 outpatient visits was 62.3%, while the accuracy for those cases with 4 and more visits was 96.1%. These data indicate the need for a required number of outpatient visits before claims can be established as accurate.

The number of hospitalizations was also associated with accuracy of diabetes insurance claims data. The accuracy of diagnoses for patients with ≥ 1 hospitalization in a year was 92%. In other words, around 8% of inpatients with a diagnosis of diabetes were not diabetic. This high rate of overdiagnosis may result from financial incentives.

A previous study found that the level of accreditation of the hospital also influenced the accuracy of diabetes insurance claims data.[27] This study found that accuracy rates in medical centers and regional hospitals exceeded those in district hospitals. However, after adjustment for those factors associated with accuracy, including number of outpatient visits, number of hospitalizations and age of the patient, the accuracy of diabetes diagnosis in medical centers and regional hospitals was lower than that in district hospitals and local clinics. This may be due to the fact that most patients with diabetes are followed up in medical centers and regional hospitals, and thus the number of outpatient visits in medical centers

Table 2. Analysis of factors associated with concordance or discordance of diabetes insurance claims data with the results of patient survey.

	Concordant (n = 1007) No. (%)	Discordant (n = 343) No. (%)	p value
Age (years)			< 0.01
< 40	42 (44.2)	53 (56.4)	
40-50	118 (64.8)	64 (35.2)	
≥ 50	847 (78.9)	226 (21.1)	
Gender			< 0.01
Male	574 (78.2)	160 (21.8)	
Female	433 (70.3)	183 (29.7)	
Number of outpatient visits			< 0.01
≤ 1	63 (21.2)	234 (78.8)	
2	28 (36.4)	49 (63.6)	
3	33 (62.3)	20 (37.7)	
≥ 4	883 (95.7)	40 (4.3)	
Number of emergent visits			< 0.01
0	952 (73.9)	336 (28.0)	
≥ 1	55 (88.71)	7 (11.29)	
Number of hospitalizations			< 0.01
0	849 (72.0)	330 (28.0)	
≥ 1	158 (92.4)	13 (7.6)	
Number of complications			< 0.01
0	699 (71.0)	285 (29.0)	
≥ 1	308 (84.15)	58 (15.85)	
Level of accreditation of the hospital at which treatment was received			< 0.01
District hospital	230 (67.9)	109 (32.2)	
Local clinic and others	305 (74.6)	104 (25.4)	
Regional hospital	224 (77.0)	67 (23.0)	
Medical center	248 (79.7)	63 (20.3)	
Follow-up department			< 0.01
Endocrinology and Metabolism	250 (87.1)	37 (12.9)	
Medicine	432 (72.5)	164 (27.5)	
Family medicine	136 (69.7)	59 (30.3)	
General practitioner	91 (72.2)	35 (27.8)	
Others	98 (67.1)	48 (32.9)	

and regional hospitals is greater than those in district hospitals and local clinics. The number of outpatient visits was the factor most associated with diagnostic accuracy.

In this study, age was also associated with diagnostic accuracy. This may be due to the fact that the prevalence of diabetes increases with age, and older people are more likely to have a diagnosis of diabetes as a result of a blood examination.

A limitation in this study was that only confirmed diabetes cases were examined. Classification of subjects as non-diabetic in insurance claims data was not independently confirmed and could not be established in this study. Those patients with diabetes treated without drug therapy or controlled by alternative medicine might have been under-reported in insurance claims data. The measurement of negative predictive values for validity of insurance claims data is another area requiring prospective study.

Another limitation of this study was the low response rate, a common situation when questionnaires are sent by mail. In this study, the average age

of respondents exceeded that of the target population. The proportions of male respondents, number of outpatient visits, emergent visits, hospitalization, and follow-up in the endocrinology and metabolism department among respondents also exceeded those of the target population. All of these were factors are associated with the accuracy of diabetes insurance claims data. Study design using the methods of medical record review or patient self-report in a personal interview would improve the quality of results.

Evidence from earlier studies suggested that the self-report was a reliable guide to the diagnosis of diabetes, with high specificity and sensitivity.[23–26] In this study, participants were asked whether they had diabetes or if they had ever been diagnosed with diabetes. Respondents answering "yes" may have included persons with impaired glucose tolerance in addition to those with diagnosed diabetes. On the other hand, the use of medical records was biased by their being recorded from the point of view of doctors. Moreover, one-sixth of patients with conditions coded in the claims data had no records in clinical data.[28]

Table 3. Multivariate logistic regression analysis of factors associated with accuracy of diabetes insurance claims data.*

	Crude OR	95% CI	Adjusted OR	95% CI
Number of outpatient visits				
< 1	1.00		1.00	
2	2.12	1.24-3.65	2.67	1.50-4.75
3	6.13	3.29-11.41	7.52	3.86-14.67
> 4	81.99	53.76-125.00	99.16	61.78-159.17
Number of hospitalizations				
0	1.00		1.00	
> 1	4.14	2.38-7.19	5.26	2.46-11.23
Age (years)				
< 40	1.00		1.00	
40-50	2.33	1.40-3.86	1.51	0.68-3.35
> 50	4.73	3.07-7.28	2.74	1.41-5.33
Level of accreditation of the hospital at which treatment was received				
District hospital	1.00		1.00	
Local clinic and others	1.39	1.01-1.91	1.83	1.11-3.01
Regional hospital	1.59	1.1-2.26	0.98	0.56-1.70
Medical center	1.87	1.30-2.67	0.62	0.36-1.08

* Eight variables were analyzed in the model: age, gender, number of outpatient visits, emergent visits and hospitalization, number of complications, level of hospital accreditation, and follow-up department.
OR = odds ratio; CI = confidence interval.

In conclusion, this study estimated the accuracy of diabetes insurance claims data at 74.6% in Taiwan. Number of outpatient visits, hospitalization, age, and the level of accreditation of the hospital were factors associated with accuracy of diabetes insurance claims data. Controlling these factors can play a very important role in maximizing the accuracy of diabetes claims data for surveillance and epidemiologic research on the public health burden of diabetes and its complications.

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