Better Continuity of Care Reduces Costs for Diabetic Patients

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Objective: To examine the effects of continuity of care on healthcare utilization and expenses for patients with diabetes mellitus.

Study Design: Longitudinal study based on claims data.

Methods: Data on healthcare utilization and expenses from a 7-year period (2000-2006) were gathered from claims data of the Taiwanese universal health insurance system. The continuity of care index (COCI) was analyzed, and the values were classified into 3 levels. Outcome variables included the likelihood of hospitalization and emergency department visit, pharmaceutical expenses for diabetes-related conditions, and total healthcare expenses for diabetes-related conditions. A generalized estimating equation that considered the effects of repeated measures for the same patients was applied to examine the effects of continuity of care on healthcare utilization and expenses.

Results: Compared with patients who had low COCI scores, patients with high or medium COCI scores were less likely to be hospitalized for diabetes-related conditions (odds ratio [OR] 0.26, 95% confidence interval [CI] 0.25, 0.27, and OR 0.58, 95% CI 0.56, 0.59, respectively) or to have diabetes-related emergency department visits (OR 0.34, 95% CI 0.33, 0.36, and OR 0.64, 95% CI 0.62, 0.66, respectively). Patients with low COCI scores incurred $126 more in pharmaceutical expenses than patients with high COCI scores. Furthermore, patients with high COCI scores had greater savings ($737) in total healthcare expenses for diabetes-related conditions than patients with low COCI scores.

Conclusion: Better continuity of care was associated with less healthcare utilization and lower healthcare expenses for diabetic patients. Improving continuity of care might benefit diabetic patients.

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For author information and disclosures, see end of text.

Diabetes mellitus (DM) is a prevalent condition with significant complications and serious consequences.[1] In many countries, soaring healthcare expenses for diabetes-related conditions have become a major concern of health authorities. In the United States, healthcare expenditures for diabetes reached an estimated $116 billion in 2007.[2] The total diabetes-related healthcare expenses in Taiwan increased from $207 million in 1998 to $466 million in 2008.[3,4] Finding ways to contain the soaring expenses for diabetes care is a major issue for healthcare policy makers worldwide.

Long-term relationships between physicians and patients are an important determinant of mutual trust and better communication. A commonly used indicator for measuring the relationship between patients and their physicians is the continuity of care. Numerous studies in the United States have shown that patients with greater continuity of care were more likely to have better healthcare outcomes.[5] Similar results have also been found in Taiwan.[6,7]

Previous research suggests that continuity of care may be particularly beneficial to patients with chronic diseases such as diabetes.[8] With a high degree of continuity of care, the ongoing relationship allows the physician to be familiar with a patient's history and current condition. Thus, physicians can continually monitor the glycemic status and detect minor conditions at earlier stages to reduce the incidence of diabetes complications. Additionally, the ongoing relationship may increase the level of mutual trust between physicians and patients, generate greater consensus during decision making, and result in better adherence to guidelines.[9] Empirical studies on continuity of care and healthcare outcomes for diabetic patients indicate that better continuity of care may lead to earlier diagnosis of diabetes,[10] higher patient satisfaction or quality of life,[11,12] and fewer hospital admissions.[13,14] Yet the association between continuity of care and healthcare expenses for diabetic patients has not been reported.

Continuity of care is closely associated with the healthcare system. The use of managed care models has expanded in the United States, and the integrated delivery system of managed care might improve continuity of the physician-patient relationship.[8] However, the policy of managed competition that encourages patients to change health plans or physicians[15] may

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reduce the continuity of care for patients. Therefore, some states have passed legislation to improve the continuity of care by promoting the physician-patient relationship as a component of managed care.[8] On the other hand, more than 99% of all residents are enrolled in Taiwan's compulsory national health insurance (NHI), and about 95% of hospitals and 90% of community clinics nationwide were contracted with NHI in 2008. There is no required referral arrangement under the NHI system, and patients are free to choose any physician based on their preferences. Facilitated by the ease of accessibility, patients in Taiwan are often criticized for their doctor-shopping behavior, such as changing doctors or making unnecessary visits.[16,17] This phenomenon may hamper the communication or trust between patients and physicians, resulting in the deterioration of continuity of care for patients. This study used longitudinal analysis of a large, representative data set from Taiwan to examine the effects of continuity of care on healthcare utilization and healthcare expense.

Take-Away Points

This study used a longitudinal analysis of a large, representative data set from Taiwan to examine the effects of continuity of care on healthcare utilization and expense for patients with diabetes mellitus (DM).

- Diabetic patients with better continuity of care had a significantly lower likelihood of hospitalization or an emergency department visit for diabetes-related conditions.
- Patients with better continuity of care for diabetes had significantly lower pharmaceutical and total healthcare expenses for diabetes-related conditions.
- Improving the continuity of care might be beneficial to patients with DM.

METHODS

Data Source

Data for this study came from the NHI claim data set obtained from the National Health Research Institute. This data set is a nationwide, population-based claim database that contains detailed records on every visit for each patient, including outpatient visits and hospital admission. The data set includes principal and secondary diagnosis codes, prescription orders, claimed expense, and copayment. Multiple year data were used in this study.

Study Design

Most of the previous studies examining continuity of care and healthcare utilization used a cross-sectional study design.[18-23] Compared with a cross-sectional design, longitudinal design possesses significant strengths. First, a longitudinal design not only accounts for variation between individuals with healthcare utilization but also accounts for unobserved time-invariant characteristics of patients (like health-seeking behavior). Second, the longitudinal design allows for estimation due to changes in continuity of care and healthcare utilization over time, whereas a cross-sectional study can only obtain information about the relationship between continuity of care and healthcare utilization at 1 given point in time.[24,25] Given the availability of the multiple-year data, the present study was conducted using a longitudinal design to strengthen the inference of the findings.

Study Population

We identified study subjects who had either a type 1 or type 2 DM diagnosis (*International Classification of Diseases, 9th Revision, Clinical Modification* [*ICD-9-CM*] code 250 or A181) and who had diabetes-specific prescriptions from the NHI claim data set in 2000-2006. We then conducted systematic sampling to select 100,000 subjects from this nationwide diabetes-related claims database. Using the data, we composed a 7-year panel (2000-2006) of claims for healthcare utilization and expenses analysis.

We applied several exclusion criteria to select appropriate study subjects. First, we excluded patients with diabetes who were younger than 18 years to ensure homogeneity of the sample. Second, because the continuity-of-care indicators are not applicable to those with very few visits, we excluded subjects who had fewer than 3 diabetes-related visits in any of the years between 2000 and 2006. This exclusion criterion has been used by previous studies.[18,20,21] Finally, to increase the comparability of continuity of care among patients with diabetes, we excluded the following treatment categories: outpatient surgery, dental care, traditional Chinese medicine, and specific services such as long-term care or home health services. As a result, 48,107 subjects were included in the study. We compiled baseline information in 2000 and then collected follow-up information for each patient over the subsequent 6 years.

Measures of Study Variables

Continuity of Care. From the several indicators available that measure continuity of care,[26] we elected to use the continuity of care index (COCI) developed by Bice and Boxerman.[27] The COCI is composed of the number of different physicians seen and the number of visits to each physician. The equation for this index is as follows:

$$COCI = \frac{\sum_{j=1}^{M} n_j^2 - N}{N(N-1)}$$

where N represents the total number of physician visits, n_j is the number of visits to the same physician, j, j represents a given physician, and M is the number of physicians. This index measures the degree to which patient visits are dispersed among different physicians, and the corresponding values (0 and 1) indicate the degree of continuity of care. A higher value corresponds with better continuity of care.

The COCI score is usually calculated by physician visits for any condition of a patient. However, in this study, we calculated the COCI score based on diabetes-related visits only. We considered that the specific COCI is more sensitive to detect the association between continuity of care and healthcare utilization for diabetic patients due to the lack of referral arrangements and the very high number of physician visits in Taiwan. Because the score of the COCI cannot be interpreted intuitively, it was divided into 3 groups based on the tertiles of the distribution for analysis. We chose COCI instead of other commonly used indicators such as the usual provider continuity index[28] because the COCI score is independent from the number of physician visits.[29]

Outcome Measures. The main outcomes measured in this study were healthcare utilization and healthcare expense. We defined diabetes-related healthcare services and expenses as claims indicating DM as the principal or secondary diagnostic *ICD-9-CM* code. The healthcare utilization variables included the likelihood of diabetes-related hospitalizations and emergency department (ED) visits. In addition, we excluded hospitalizations or ED visits for diagnosis of an injury, poisoning (*ICD-9-CM* 850-995), and all supplementary classifications (V-codes) like chemotherapy, because these specific services were not associated with regular healthcare-seeking behavior of diabetic patients.

The healthcare expenses were calculated using NHI claim data and included diabetes-related pharmaceutical expenses and diabetes-related total healthcare expenses (including outpatient visits, hospitalizations, and ED visits) incurred by patients. The healthcare expenses during 2001 and 2005 were adjusted for inflation to allow for comparison with figures from 2006 in the regression models. Additionally, we computed the predicted mean expense for each patient, holding patient characteristics constant, and compared differences in diabetes-related pharmaceutical and total healthcare expense for each category of COCI.

Other Variables. Several confounding factors were controlled for in the regression models. These variables include patient's age and sex, low-income status, the total number of physician visits in the previous year, the likelihood of hospitalization in the previous year, and diabetes complication severity index score in the previous year.[30] Enrollment in the NHI diabetes pay-for-performance program was also included because a previous study reported significant effects of the program on healthcare utilization.[31]

Statistical Analysis

Descriptive statistics, including frequency, percentage, mean, and standard deviation, were calculated for this study. We used generalized estimating equations (GEEs) to create an extended, generalized, linear model to account for correlated data from the longitudinal data analysis.[25] Based on the characteristics of the variables used herein, the likelihoods of diabetes-related hospitalization and ED visit were analyzed by using a logit link with a binomial distribution. Additionally, values from the healthcare expenses were right skewed; therefore, we used the GEE model with a logarithmic link function with a Gamma distribution. A similar approach has been used in the econometric literature to assess healthcare expenses.[32,33]

The time-dependent variables in these models included age, total number of physician visits, the likelihood of hospitalization, diabetes complication severity index score, and enrollment in the NHI diabetes pay-for-performance program. The time-independent variables included sex and low-income status. In addition, this study included time dummy variables to control for characteristics that remain constant among patients but may change over time. Our analyses were performed using SAS version 9.1.3 (SAS Institute, Cary, North Carolina) and Stata 9.1 (StataCorp, College Station, Texas).

RESULTS

Table 1 presents the characteristics of the study sample in 2001. The mean age of subjects was 60.65 years with the majority of patients being female, and 0.86% of them were of low-income status according to the government's strict definition of the poverty line in Taiwan. With regard to the health status of patients, the average number of physician visits for any condition in the previous year was 28.42, which was higher than the national average of 15 visits, and the hospitalization rate in the previous year was 15.87%. Additionally, 47.23% of the study sample had a diabetes complication severity index score of 0, whereas 25.10% had a score of 2 or higher.

The study variables according to year are presented in **Table 2**. The COCI scores remained stable (0.64-0.66) from 2001 to 2006. In terms of healthcare utilization during this time period, the rate of diabetes-related hospitalizations increased from 13.59% to 20.64%, and the rate of ED visits increased from 6.67% to 11.95%. Additionally, diabetes-related pharmaceutical expenses increased from New Taiwan (NT)

Table 1. Characteristics of the Study Sample, 2001 (N = 48,107)

Variable	Value
Demographic characteristics	
Age, mean (SD)	60.65 (11.31)
Sex, No. (%)	
Male	21,832 (45.38)
Female	26,275 (54.62)
Low income status, No. (%)	415 (0.86)
Health status	
Physician visits in the previous year, No. (%)	
Low (4-19 visits)	16,959 (35.25)
Medium (20-32 visits)	16,909 (35.15)
High (≥33 visits)	14,239 (29.60)
Physician visits in the previous year, mean (median, SD)	28.42 (24.00, 17.88)
DCSI score in the previous year, No. (%)	
0	22,720 (47.23)
1	13,312 (27.67)
2+	12,075 (25.10)
Hospitalization in the previous year, No. (%)	7636 (15.87)

DCSI indicates diabetes complication severity index.

$16,428 to NT $23,728, and total diabetes-related healthcare expenses increased from NT $28,785 to NT $49,776 (NT $33 equaled $1 in 2001).

Table 3 presents results from the GEE models, which examined effects of COCI on the likelihood of diabetes-related hospitalization and ED visit. Patients with high or medium COCI scores were less likely to be hospitalized for diabetes-related conditions than were those with low COCI scores (odds ratio [OR] 0.26, 95% confidence interval [CI] 0.25, 0.27, and OR 0.58, 95% CI 0.56, 0.59, respectively). We also found that patients with high or medium COCI scores were less likely to have diabetes-related ED visits compared with patients with low COCI scores (OR 0.34, 95% CI 0.33, 0.36, and OR 0.64, 95% CI 0.62, 0.66, respectively).

Results from the GEE models concerning the effect of COCI on diabetes-related pharmaceutical and diabetes-related total healthcare expenses are listed in Table 4. Patients with high or medium COCI scores incurred lower pharmaceutical expenses than did patients with low COCI scores (β –0.14, P <.001; β –0.06, P <.001). Patients with high or medium COCI scores tended to incur lower diabetes-related total healthcare expenses than did patients with low COCI scores (β –0.53, P <.001; β –0.29, P <.001).

The Figure presents the mean predicted expenses, including diabetes-related pharmaceutical expenses and diabetes-related total healthcare expenses, which were significantly different among the low, medium, and high COCI groups. With regard to pharmaceutical expenses, patients with low

Table 2. Variables of Interest According to Year (N = 48,107)

Variable	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006
COCI score, mean (SD)						
COCI score based on DM-related visits	0.65 (0.30)	0.66 (0.30)	0.65 (0.30)	0.64 (0.30)	0.65 (0.30)	0.66 (0.30)
Healthcare utilization, No. (%)						
DM-related hospitalization	6536 (13.59)	7099 (14.76)	7250 (15.07)	8338 (17.33)	8911 (18.52)	9928 (20.64)
DM-related ED visits	3211 (6.67)	3624 (7.53)	3991 (8.30)	4596 (9.55)	5097 (10.60)	5748 (11.95)
Healthcare expenses, NT $, mean (SD)						
DM-related pharmaceutical expenses	16,428 (16,401)	19,160 (18,620)	21,175 (20,309)	23,649 (22,519)	22,816 (23,099)	23,728 (28,633)
DM-related total healthcare expenses	28,785 (40,414)	33,386 (46,922)	36,638 (49,525)	42,672 (61,561)	43,824 (67,013)	49,776 (89,754)

COCI indicates continuity of care index; DM, diabetes mellitus; ED, emergency department; NT, New Taiwan.

Table 3. Generalized Estimating Equation Models for the Effects of COCI on Diabetes-Related Healthcare Utilization

	Hospital Admission		ED Visit	
Variable	**OR**	**95% CI**	**OR**	**95% CI**
COCI score (reference group: low [0.00-0.47])				
Medium (0.48-0.86)	0.58	0.56, 0.59	0.64	0.62, 0.66
High (0.87-1.00)	0.26	0.25, 0.27	0.34	0.33, 0.36
Demographic characteristics				
Age (reference group: <18-44 y)				
45-65 y	1.11	1.05, 1.16	0.91	0.85, 0.97
65 y+	1.50	1.43, 1.58	1.13	1.06, 1.21
Female	1.01	0.99, 1.04	1.24	1.20, 1.28
Low income status	1.71	1.53, 1.92	1.69	1.47, 1.94
Health status				
Physician visits in the previous year (reference group: low [4-19 visits])				
Medium (20-32 visits)	1.13	1.10, 1.16	1.09	1.05, 1.13
High (33 visits +)	1.37	1.33, 1.41	1.30	1.26, 1.36
Hospitalization in the previous year	1.66	1.62, 1.70	1.64	1.59, 1.69
DCSI score in the previous year (reference group: 0)				
1	1.16	1.13, 1.19	1.14	1.10, 1.18
2+	1.54	1.50, 1.59	1.42	1.37, 1.47
Enrolled in P4P program	0.83	0.80, 0.86	0.93	0.89, 0.98
Year (reference group: 2001)				
2002	1.09	1.05, 1.13	1.13	1.08, 1.19
2003	1.08	1.04, 1.12	1.21	1.16, 1.27
2004	1.29	1.25, 1.34	1.42	1.36, 1.49
2005	1.37	1.32, 1.42	1.56	1.49, 1.63
2006	1.58	1.52, 1.63	1.78	1.70, 1.86

CI indicates confidence interval; COCI, continuity of care index; DCSI, diabetes complication severity index; ED, emergency department; OR, odds ratio; P4P, pay-for-performance.

COCI scores spent NT $4155 more than did patients with high COCI scores. In terms of total healthcare expenses, we calculated a larger savings (NT $24,314) for patients with high COCI scores versus patients with low COCI scores.

Sensitivity Analyses

We conducted 2 sensitivity analyses to improve the robustness of this study. First, we used the other 2 commonly used indicators of continuity of care to examine the association. The usual provider continuity index was defined as the number of outpatient visits to the most frequently seen physician divided by the total number of outpatient visits.[28] The usual provider continuity index would therefore always be larger than zero, with a higher value corresponding to a higher continuity of care. In addition, the sequential continuity index was defined as the portion of consecutive visit pairs at which the same provider is seen.[34] This score also ranges from 0 to 1, with a higher value representing a better continuity-of-care status. We found that the results were similar to those obtained using COCI (**eAppendix A** and **eAppendix B,** available at **www.ajmc.com**). Second, we also examined whether the effect of the COCI on healthcare utilization and healthcare expense was independent of the number of physician visits. We stratified the number of physician visits into 3 tertiles (low-visit, medium-visit, and high-visit groups) and found almost similar results within each group (**eAppendix C** and **eAppendix D,** available at **www.ajmc.com**).

DISCUSSION

We examined the effects of continuity of care on healthcare utilization and healthcare expenses for patients with DM

Table 4. Generalized Estimating Equation Models for the Effects of COCI on Diabetes-Related Healthcare Expense

	Pharmaceutical Expenses			Total Healthcare Expenses		
Variable	β	**SE**	***P***	β	**SE**	***P***
Intercept	9.51	0.01	<.001	10.13	0.02	<.001
COCI score (reference group: low [0.00-0.47])						
Medium (0.48-0.86)	−0.06	0.004	<.001	−0.29	0.01	<.001
High (0.87-1.00)	−0.14	0.004	<.001	−0.53	0.01	<.001
Demographic characteristics						
Age (reference group: <18-44 y)						
45-65 y	0.12	0.01	<.001	0.09	0.02	<.001
65+ y	0.18	0.01	<.001	0.19	0.02	<.001
Female	−0.04	0.01	<.001	−0.04	0.01	<.001
Low income status	0.08	0.03	0.008	0.28	0.02	<.001
Health status						
Physician visits in the previous year (reference group: low [4-19 visits])						
Medium (20-32 visits)	0.08	0.01	<.001	0.09	0.01	<.001
High (33 visits +)	0.13	0.01	<.001	0.17	0.01	<.001
Hospitalization in the previous year	0.09	0.004	<.001	0.27	0.01	<.001
DCSI score in the previous year (reference group: 0)						
1	0.09	0.01	<.001	0.12	0.01	<.001
2+	0.15	0.01	<.001	0.30	0.01	<.001
Enrolled in P4P program	0.10	0.01	<.001	−0.01	0.01	0.151
Year (reference group: 2001)						
2002	0.15	0.01	<.001	0.14	0.01	<.001
2003	0.23	0.01	<.001	0.21	0.01	<.001
2004	0.34	0.01	<.001	0.37	0.01	<.001
2005	0.28	0.01	<.001	0.38	0.01	<.001
2006	0.32	0.01	<.001	0.52	0.01	<.001

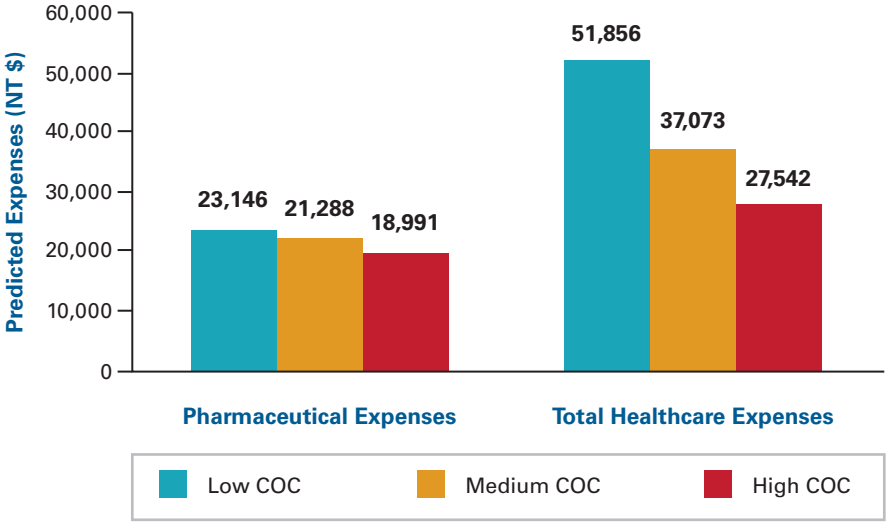
COCI indicates continuity of care index; DCSI, diabetes complication severity index; P4P, pay-for-performance.

by calculating COCI scores for diabetes-related visits. The COCI scores ranged from 0.64 to 0.66, which were higher than the COCI scores for all physician visits among the general public reported in a previous study.[6] Findings from our analysis showed that better continuity of care was significantly associated with a lower likelihood of diabetes-related hospitalizations and ED visits. This study also found that better continuity of care for DM was significantly associated with lower diabetes-related pharmaceutical expenses and diabetes-related total healthcare expenses.

The COCI scores using only diabetes-related visits in these years (0.64-0.66) are higher than the scores calculated using all visits (0.35-0.36). Under Taiwan's NHI, patients can visit a specialist without referral; a high COCI score implies that many diabetic patients tend to see the same doctors for diabetes care. The COCI scores tend to be much lower for visits for all conditions, indicating poorer continuity of care in general. However, COCI scores are difficult to interpret in absolute numbers and should not be compared with other findings from different healthcare systems.

In terms of the effects of continuity of care on healthcare utilization, our findings were similar to those of previous studies focusing on patients with diabetes. Knight et al found that better continuity of care by family physicians was associated with decreased hospitalization among the elderly with diabetes in Canada.[13] A study by Lin et al found that a higher level of continuity of care was associated with a lower risk of hospitalization for diabetic complications among patients with

Figure. Predicted Expenses for Diabetes-Related Conditions by the 3 Levels of Continuity of Care



COC indicates continuity of care; NT, New Taiwan.

diabetes in Taiwan.[14] By using a longitudinal study analysis to account for repeated measures from the same patients, this study enhanced the robustness of previous findings. Furthermore, we also found that better continuity of care may lead to a lower likelihood of diabetes-related ED visits. The findings imply that increased continuity of care for DM may result in better healthcare outcomes.

Previous studies have shown that better continuity of care is associated with lower healthcare expenses in general. Weiss et al found that longer relationships between physicians and patients were associated with a lower cost of inpatient and outpatient care for the elderly in the United States.[35] Raddish et al reported a negative relationship between continuity of care and prescription costs for 5 target diseases in the United States.[36] Similarly, De Maeseneer et al reported significant effects of continuity of care on total healthcare costs in family practices in Belgium.[37] Our study contributes to this current literature by focusing on expenses related to diabetes care.

We found that diabetic patients with a high level of continuity of care incurred lower annual expenses for medications and healthcare overall, spending NT $4155 less (approximately $126) for medications and NT $24,314 less (approximately $737) for healthcare overall than did those patients with a low level of continuity of care in Taiwan. The reduced pharmaceutical and healthcare expenses could be explained by the ongoing relationship between the healthcare provider and the patient, which may improve guideline adherence,[9] reduce unnecessary laboratory testing and test repetition,[38,39] and avoid polypharmacy.[40] Additionally, reduced healthcare expenses may be associated with fewer hospital admissions or ED visits that result from poor control of diabetes. However, determining the mechanism of this effect is beyond the scope of this study and is worthy of further exploration.

Limitations to this study need to be addressed. First, we did not include certain patient characteristics that may simultaneously affect both the continuity of care and healthcare outcomes; these include socioeconomic variables and health-seeking behaviors. However, we used a longitudinal analysis technique that was able to account for the time-invariant, unobserved patient characteristics, thus increasing the robustness of the findings. Second, this study utilized NHI claims data, which do not contain information about self-paid physician visits. We assumed that the proportion of such visits would be minimal with respect to total healthcare visits in Taiwan. Finally, there are some unique aspects of Taiwan's healthcare system and thus the results may not be generalizable to other populations.

In conclusion, in a healthcare system with universal coverage and a high level of access to care, this study indicates that better continuity of care is associated with less healthcare utilization and lower healthcare expenses for diabetic patients. Improving the continuity of care might be beneficial for patients with DM.

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