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Continuity of diabetes care is associated with avoidable hospitalizations: evidence from Taiwan's National Health Insurance scheme

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Abstract

Objective. Taiwan's health-care system allows patients to utilize specialty services without referrals by primary care providers. This discontinuity of care may lead to increases in future hospitalizations. This study aims to determine whether the discontinuity of care is associated with the risk of hospitalization.

Design. A secondary data analysis based on a claim data of a nationally representative random sample of diabetic patients in Taiwan. A usual provider continuity (UPC) index was developed—a ratio of the visits to the physician that subjects most usually see relevant to diabetes care to the total physician visits relevant to diabetes care—to investigate its association with the risk of hospitalization.

Setting. Taiwan's National Health Insurance scheme from 1997 through 2002.

Participants. Totally 6476 diabetic patients.

Intervention(s). None.

Main Outcome Measure(s). Diabetes-related short-term and long-term ambulatory care sensitive condition (ACSC) admissions.

Results. Patients with ACSC admissions had significantly lower UPC scores compared with those without ACSC admissions. Using a Cox regression model that controlling for age, sex, severity of diabetes and the number of total visits, patients with low to medium continuity of care (UPC <0.75) were found to be significantly associated with increased risk of hospitalization as compared with patients with high continuity of care, especially for long-term ACSC admissions (relative risk: 1.336 [1.019–1.751]).

Conclusions. Higher continuity of care with usual providers for diabetic care is significantly associated with lower risk of future hospitalization for long-term diabetic complication admissions. To avoid future hospitalization, health policy stakeholders are encouraged to improve the continuity of care through strengthening the provider–patient relationships.

Keywords: continuity of care, ambulatory care, hospitalization, diabetes

Introduction

In Taiwan, the cost of care for diabetic patients accounts for about 11.5% of the total heath care expenditure, and diabetes contribute to 22.1% of total inpatient days [1]. Nevertheless, some hospitalizations of diabetic patients may be preventable [2]. The US Agency of Healthcare Research and Quality (AHRQ) identified diabetes as one of the ambulatory care sensitive conditions (ACSCs) for which good access to ambulatory care would decrease the likelihood of future hospitalization [3]. Apart from access to ambulatory care, the American Diabetes Association also recommends that continuity of care is an essential component of good quality diabetic care [4].

Continuity of care has been defined as the 'relatedness between past and present care in conformity with the therapeutic needs of the clients' [5]. Systematic reviews show that patients with higher continuity of care have better patient outcomes [6–9] and fewer hospitalization [8–13] compared with their counterparts. Among the reviewed studies, few focused on diabetes care. Christakis *et al.* [8] reported that higher continuity of care by primary care providers (general pediatricians and family physicians) for children with diabetes enrolled in the US Medicaid program had decreased risk of hospitalization for diabetic ketoacidosis. Knight *et al.* [13] reported that higher continuity of family physician care for elderly with diabetes enrolled in Canada's universal health insurance program was associated with a lower likelihood of hospitalization. Parchman *et al.* [9] demonstrated that continuity of care with a primary care provider was associated with better glucose control. However, these previous diabetes studies are largely based on a 1–2 year observational period [8, 9] rather than a longer time period [13]. Given the chronic progressive nature of diabetes, it is important to investigate whether continuity of care has a longer term effect on the decrease of diabetes-related hospitalization.

In Taiwan, a National Health Insurance (NHI) scheme has been implemented in 1995 which covers more than 96% of the entire population. By design the NHI scheme allows patients to utilize specialty services for a small co-payment and without requiring a referral arrangement. It is possible that the provision of discontinuous care will increase the risk of overusing advanced but unnecessary health-care services, potentially compromising patients' health outcomes. In contrast to previous studies, the advantage of using NHI claims data is that it allows us to observe different types of health-care utilization and outcomes of an individual diabetic patient for a longer period of time. The purpose of this study is to determine the relationship between continuity of care and the risk of future hospitalization for diabetic patients from a long-term perspective using the administrative claims data from the Taiwan's NHI scheme. Specifically, we use a survival analysis to focus on whether a decline in the hospitalization rate could be attributed to the provision of better continuity of care.

Methods

Data

This study analyzed claims data collected from a random sample of patients who were eligible in NHI ($N = \sim 200\,000$) between 1997 through 2002. This individual-based claims data set is maintained by the National Health Research Institute (NHRI) in Taiwan, and has been used for a wide range of research, including research on patients with diabetes [1, 14]. The data contain comprehensive inpatient and ambulatory care records, including unique patient and physician identification numbers, patients' gender, birthday and ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) codes, for each encounter. Patients were defined as having diabetes if one of the following criteria were met: (i) presentation of an ambulatory visit with principal diagnosis of ICD-9-CM code of 250.0–250.9, 362.0–362.2 or of ICD-9 A-code (abridged code) of A181; (ii) prescription for anti-diabetic drugs accompanied with any secondary diagnoses of the above codes. To be eligible for inclusion, patients had to make at least four visits for diabetes treatment, with the first visit no later than 1 January 2002, and had to be eligible in NHI continuously during 1997 through 2002.

Variables

The primary outcome variable is dichotomous and indicates whether or not a diabetic patient has had any diabetes-related ACSC admissions after his or her first visit for treating diabetes. We used the diabetes-related ACSC admissions defined by AHRQ including (i) short-term complications (ICD-9-CM code of 250.1–250.3), (ii) uncontrolled diabetes (ICD-9-CM code of 250.0), (iii) long-term complications (ICD-9-CM code of 250.4–250.9), and (iv) lower extremity amputation (ICD-9-CM procedure code of 84.1) [3]. We grouped the homogenous diagnosis codes by two categories and analyzed them separately in survival analyses: (1) short-term ACSC admissions (including short-term complications and uncontrolled diabetes) and (2) long-term ACSC admissions (including long-term complications and lower extremity amputation). Patients who had no ACSC admissions until the end of study period (31 December 2002) were classified as censored observations in the survival analyses for the hospitalization rate.

Although several indices measuring continuity of care have been proposed [15], for this study we chose the usual provider continuity (UPC) index defined by Breslau and Reeb [16] as the primary predictor variable. We specifically defined UPC index as a ratio of the visits to the physician that patients see most often relevant to diabetes care to the total physician visits relevant to diabetes care, with the ratio ranging in value from 0 to 1. This UPC index was selected because it is consistent with the concept of having a regular provider for the primary care, and is intuitive for interpretation [6]. We calculated the UPC index by using the information of each patient's ambulatory visits for diabetes treatment before hospitalization for ACSCs or until the end of the study period. We, however, excluded patients with less than four visits from the analysis so as to generate a meaningful UPC score [5, 6]. This selected criterion is based on the findings of a previous study which examined the accuracy of diabetic diagnosis in Taiwan. This study suggested that the concordant rate between Taiwan's NHI claim data and patient's self-report was 95.7% when a patient had more than four visits recorded in the NHI database [17].

We also included several important covariates in the analysis to better account for their influences on the relationships between the continuity of care and hospitalization. In addition to age and sex, three other variables associated with severity of diabetes patients were also adjusted in the survival analysis model. The first covariate is the number of complications or comorbidities. The use of the claims data set allows us to measure the presence of seven different diabetic complications or comorbidities defined by Newton and her colleagues [18], including cardiovascular disease, essential hypertension, foot/lower-extremity problems, peripheral vascular disease, cerebrovascular disease, renal disease and eye disease. We further generated a summation index for diabetic complications or comorbidities by adding up the total number of individual complications or comorbidities with an equal weight across all ambulatory visits during the time window where we calculated the UPC scores. The second covariate is the total number of visits for diabetes treatment per year. We assumed that the greater the number of visits per year might indicate more severity for a diabetic patient, therefore increasing the risk of hospitalizations. The third covariate is the type of practice setting of the patients' usual provider, including medical centers, regional hospitals, district hospitals and primary care clinics. We assumed that the visit of different settings may be associated with different levels of complexity in their diabetes conditions. In this study, we focused on subjects who were newly diagnosed with diabetes. We treated subjects as new cases of diabetes if no any claim records for diabetic treatment are found before 1 January 1998.

Statistical methods

We conducted bivariate analyses to compare the difference between diabetic patients with or without hospitalization. Continuous variables (such as age, UPC, numbers of complications/comorbidities) were tested using independent *t*-test, whereas categorical variable (such as gender) was analyzed using χ^2 test. We performed Cox proportional hazard regression to estimate the relative risk (RR) of hospitalization and 95% confidence interval (95% CI) associated with the continuity of care while controlling for other covariates. We also compared the RR of hospitalization by three levels of continuity of care. We defined the three levels as approximately equal patient number based on their UPC scores (<0.47, 0.47 to 0.75 and above 0.75). For the comparison purpose, we used the group with highest UPC scores as a referent. Finally, we plotted the cumulative hazard function for three levels of continuity of care by taking male patients, 60 years of age, two complications, and 48 visits as an example which represent roughly the mean value of all covariates. All analyses were conducted by using SPSS 13.0 and the testing results with $P < 0.05$ were regarded as statistically significant.

Results

As presented in Table 1, there were 6476 diabetic patients in our study sample, and 412 of them (6.4%) had been hospitalized for ACSC admissions during our study period. The mean age of patients was 58.8 years; 48.6% were male and 40.3% were identified as new cases. About one-third of the patients (31.9%) who visited primary care clinics to treat their diabetic condition had a mean UPC score 0.61. That is, the number of visits to the same physician a diabetic patient usually attended accounted for about 61% of total visits for diabetes treatment. The mean number of complications or comorbidities was 2.54, the mean of visits per year was 10.56 within our 6-year observational window. Compared with non-hospitalized patients, hospitalized patients had significantly lower UPC scores, higher number of complications or comorbidities, and more visits per year (all with $P < 0.05$).

Using the high continuity of care group (UPC more than 0.75) as a referent, the Cox regression model showed that diabetic patients with medium continuity of care (0.47–0.75) were 27.6% more likely to be hospitalized for short-term ACSCs (RR: 1.276 [95% CI: 0.626–2.598]) after controlling

Table 1 Summary of study sample

Variable	Patients without hospitalization ($N = 6064$)	Patients with hospitalization ($N = 412$)	Total sample ($N = 6476$)
Male (%)	48.9	44.2	48.6
New case (%)[a]	42.0	14.3	40.3
Level (%)			
Medical centers	26.0	26.2	26.0
Regional hospitals	22.4	22.8	22.4
District hospitals	19.6	20.1	19.7
Primary care clinics	32.0	30.8	31.9
Mean age (SD)[b]	58.68 (12.66)	60.56 (12.43)	58.80 (12.65)
Mean UPC (SD)[c]	0.62 (0.25)	0.57 (0.23)	0.61 (0.25)
Mean numbers of CC (SD)[c]	2.50 (1.66)	3.06 (1.63)	2.54 (1.67)
Mean visits for diabetes treatment per year (SD)[c]	10.30 (5.81)	15.75 (9.42)	10.56 (6.25)

CC, complications or comorbidities; SD, standard deviation.
[a]χ^2 test, $P < 0.001$. [b]*t*-test, $P < 0.01$. [c]*t*-test, $P < 0.001$.

Table 2 Cox regression model for short-term and long-term ACSC admissions[a]

	Short-term ACSC admissions, RR (95% CI)	Long-term ACSC admissions, RR (95% CI)
Continuity[b]		
Medium	1.276 (0.626–2.598)	1.315 (1.000–1.728)[c]
Low	1.124 (0.547–2.310)	1.336 (1.019–1.728)[c]
Male	1.074 (0.811–1.424)	1.046 (0.942–1.162)
Settings		
Medical centers	0.863 (0.394–1.890)	1.102 (0.837–1.449)
Regional hospitals	1.227 (0.573–2.631)	1.152 (0.864–1.533)
District hospitals	1.167 (0.537–2.537)	0.922 (0. 680–1.249)
New case	0.402 (0.171–0.945)[c]	0.542 (0.395–0.745)[d]
Age	0.873 (0.801–0.951)[d]	1.046 (0.942–1.162)
Age^2	1.001 (1.000–1.002)[d]	1.000 (1.000–1.002)
Numbers of CC	0.914 (0.752–1.110)	0.954 (0.888–1.025)
Visits for diabetes treatment per year	1.083 (1.053–1.114)[d]	1.089 (1.078–1.100)[d]

CC, complications or comorbidities.
[a]Short-term ACSC admissions include uncontrolled diabetes admissions and short-term complication admissions, long-term ACSC admissions include long-term complications and lower extremity amputation. [b]High continuity, female, primary care clinics and old cases were referents. [c]Wald's test, $P < 0.05$. [d]Wald's test, $P < 0.01$.

for covariates (Table 2). The difference in the risk of being hospitalized between low continuity (UPC <0.47) and high continuity groups was less profound (RR: 1.124 [95% CI: 0.547–2.310]). Nevertheless, the difference was not statistically significant in above comparisons due in part to the small number of short-term ACSC admissions ($N = 50$). For long-term ACSC admissions, both low (RR: 1.336 [95% CI: 1.019–1.751]) and medium (RR: 1.315 [95% CI: 1.000–1.728]) continuity groups demonstrated higher risk of hospitalization than those with high continuity of care after controlling for covariates. However, the pattern in the association between continuity of care and future hospitalization seemed non-linear.

Figure 1 plots the cumulative hazard for each continuity group against observation days revealing that the RR of short-term hospitalization was consistently lower in the higher continuity group, which suggests that there was a negative association between the continuity of care and risk of hospitalization. Figure 2 reveals that the hazard curves of the long-term hospitalization between low and medium continuity of care groups nearly overlapped; but the discrepancy between both groups was significantly larger as compared with the high continuity of care group. The log rank test (Mantel-Cox) suggests that the goodness of fit of the Cox proportional hazard regression for short-term and long-term ACSC admission were not statistically significant; the log ranks were 0.226 ($P = 0.893$) and 3.887 ($P = 0.143$) for short-term and long-term ACSC admission, respectively.

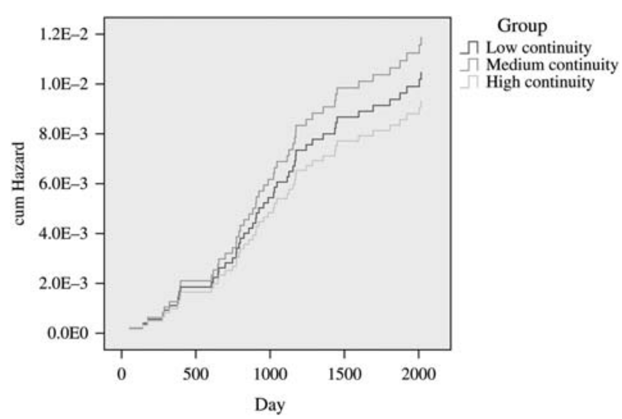

Figure 1 Risk of short-term ACSC admissions for diabetic patients in three continuity groups. Log rank (Mantel-Cox) = 0.226, $P = 0.893$.

Discussion

The results of this study demonstrate that higher continuity of care with usual providers for diabetic care is significantly associated with lower risk of future hospitalization for long-term diabetic complication admissions. One previous study had reported that having a regular provider of care was associated with the decreased risk of hospitalization for diabetic patients [8]. From the measurement perspective, we believe this study improves the precision of estimating the effect of care continuity on health outcomes. Instead of using a dichotomous variable to observe hospitalization within a one-year window, the use of 6-year claim data in this study allows us to estimate an UPC index for longer term and enable us to better understand its consequence on care outcome.

The association with continuity of care is less significant for short-term complication admissions may be in part due to the observation of a small number of cases. This finding

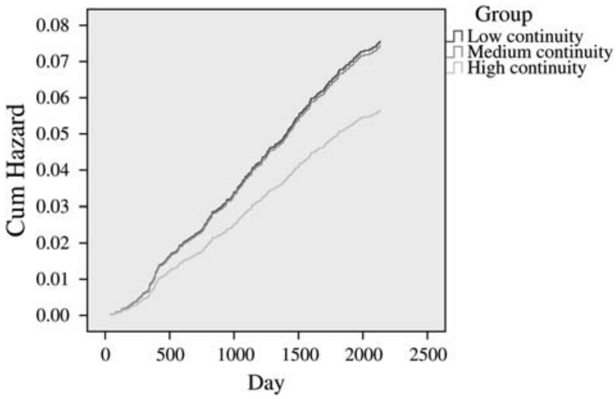

Figure 2 Risk of long-term ACSC admissions for diabetic patients in three continuity groups. Log rank (Mantel-Cox) = 0.226, $P = 0.893$.

is consistent with a previous study which reported that the effect of continuity of care is significant for long-term ACSC admissions, but not for short-term ACSC admissions [19]. The effect of care continuity on the decreased risk of future hospitalization is also similar to the finding from a study which focused on the children with asthma—one of AHRQ's ACSC conditions as well [10]. Our findings, however, contributed significantly to the extant evidence in a sense that the effect on the reduction in the risk of hospitalization was significant only if the level of continuity of care went beyond the 75% of visits to the same provider. That is, the benefit of improving continuity of care for the avoidable hospitalization seems to be less significant at the lower through medium levels (i.e. less than 75%).

Several reasons could explain the finding that only the highest level of continuity of diabetic care is associated with lower hospitalization for diabetic care. First, diabetic patients may benefit more if they identified and visited the same health-care provider [20]. Evidence suggests that patients with high-care continuity tend to be more satisfied with the care and are more willing to comply with physician's recommendations and adhere to treatment regimes as compared with their counterparts [21]. As a matter of fact, improving continuity of care associated with diabetes is a complex task which is comprised of several important elements. These elements include longitudinal continuity (i.e. receiving regular advice over time), relational continuity (i.e. having a relationship with a usual care provider who took time to listen and explain), flexible continuity (i.e. flexibility of service provision in response to changing needs) and team and cross-boundary continuity (i.e. co-ordination between staff members, and across hospital and primary care settings) [22, 23]. We believe higher continuity of care highly relied on the achievement of all these elements. Second, a regular provider may be more acquainted with patients' health problems, especially for a chronic disease, therefore allows to spend more time in probing possible complications. The higher continuity of care may establish a trusting provider–patient relationship, which is one important components of better health outcome [24].

As to why the effect of continuity of care on the short-term ACSC admission is not significant, one possible explanation is that short-term ACSC admissions are more sporadic in nature and may arise from any factor that produces non-compliance. These factors are likely beyond the control of physician.

Our study has its limitations. First, the causal relationship between continuity of care and the risk of future hospitalization is inconclusive. It can be the case where patients with higher continuity of care are generally healthier than those with lower continuity. Although our study had used two covariates to control for the severity of diabetics, other possible confounding factors (such as health literacy, diet, exercise, etc.) other than those two covariates may make patients with lower continuity of care be more likely to be hospitalized. However, diabetic patients with longer duration of care under one general practitioner tended to be sicker [25]. Another explanation may be that diabetes-related ACSC admissions were originally developed for evaluating the access and quality of care at a population level. The validity of applying them to diabetic patients to evaluate the effect of continuity of care on the risk of hospitalization is yet to be established. Although we had controlled for the number of visits as a proxy of accessibility to ambulatory care, we were unable to control for other confounding factors, such as education level or inpatient resource available to patients that may differ between patients with high or low continuity. Furthermore, diabetes-related ACSC admissions only include principal diagnoses as a signal of diabetic admissions, hence other admissions which may have resulted from lower continuity of ambulatory care were basically excluded in this study. As a result, the relationship between the continuity of care and risk of hospitalization may be underestimated.

Despite these limitations, our findings have important policy implications for delivering care to patients with chronic diseases such as diabetes, especially for Taiwan's health-care system in which patients can select physicians from any part of the country. Our findings suggest that to reduce future hospitalizations associated with diabetics and thereby control costs, health policy stakeholders could develop initiatives to improve continuity of care and strengthen provider–patient relationships, either by establishing a family doctor system or extending a shared delivery system. Additionally, given the rich administrative database available within the NHI program, health authorities can identify specific patients with lower continuity of care and provide interventions to improve their continuity or their compliance with medical regimens. Health authorities may also use the UPC index as a tool to gauge the performance of providers in delivering continuous patient care a the level of the provider or system.

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References

1. Lin T, Chou P, Lai MS *et al*. Direct costs-of-illness of patients with diabetes mellitus in Taiwan. *Diabetes Res Clin Pract* 2001; **54**:s43–s46.
2. Bindman AB, Grumbach K, Osmond D *et al*. Preventable hospitalizations and access to health care. *JAMA* 1995;**274**:350–1.
3. Agency for Healthcare Research and Quality. Refinement of the HCUP Quality Indicators. AHRQ Pub. No. 01-0035, Rockville, MD, 2001.
4. American Diabetes Association. Standards of medical care for patients with diabetes mellitus. *Diabetes Care* 2000;**23**:s32–s34.
5. Bass RD, Windle C. Continuity of care: an approach to measurement. *Am J Psychiatry* 1972;**129**:196–201.
6. Cabana MD, Jee SH. Does continuity of care improve patient outcomes? *J Fam Pract* 2004;**53**:974–80.
7. Saultz JW, Lochner J. Interpersonal continuity of care and care outcomes: a critical review. *Ann Fam Med* 2005;**3**:159–66.
8. Christakis DA, Feudtner C, Pihoker C *et al*. Continuity and quality of care for children with diabetes who are covered by Medicaid. *Ambul Pediatr* 2001;**2**:99–103.
9. Parchman ML, Pugh JA, Noël PH *et al*. Continuity of care, self management behaviors, and glucose control in patients with type 2 diabetes. *Med Care* 2002;**40**:137–44.
10. Christakis DA, Mell L, Koepsell TD *et al*. Association of lower continuity of care with greater risk of emergency department use and hospitalization in children. *Pediatrics* 2001;**107**:524–9.
11. Mainous AG, 3rd, Gill JM. The importance of continuity of care in the likelihood of future hospitalization: is site of care equivalent to a primary clinician? *Am J Public Health* 1998; **88**:1539–41.
12. Gill JM, Mainous AG, 3rd. The role of provider continuity in preventing hospitalizations. *Arch Fam Med* 1998;**7**:352–7.
13. Knight JC, Dowden JJ, Worrall GJ *et al*. Does higher continuity of family physician care reduce hospitalizations in elderly people with diabetes? *Popul Health Manag* 2009;**12**:81–6.
14. Wang SL, Chiou JM, Chen CJ *et al*. Prevalence of non-Insulin-dependent diabetes mellitus and related vascular disease in southwestern arseniasis-endemic and nonendemic areas in Taiwan. *Environ Health Perspect* 2003;**111**:155–9.
15. Steinwachs DM. Measuring provider continuity in ambulatory care: an assessment of alternative approach. *Med Care* 1979; **17**:551–65.
16. Breslau N, Reeb K. Continuity of care in a university-based practice. *J Med Educ* 1975;**50**:965.
17. Lin CC, Lai MS, Syu CY *et al*. Accuracy of diabetes diagnosis in health insurance claims data in Taiwan. *J Formos Med Assoc* 2005;**104**:157–163.
18. Newton KM, Wagner EH, Ramsey SD *et al*. The use of automated data to identify complications and comorbidities of diabetes: a validation study. *J Clin Epidemiol* 1999;**52**: 199–207.
19. Gill JM, Mainous AG. The role of provider continuity in preventing hospitalizations. *Arch Fam Med* 1998;**7**:352–7.
20. Casparie AF, van der Waal MA. Differences in preferences between diabetes patients and diabetologists regarding quality of care: a matter of continuity and efficiency of care? *Diabet Med* 1995;**12**:828–32.
21. Wasson JH, Sauvigne AE, Mogielnicki RP *et al*. Continuity of outpatient medical care in elderly men: a randomized trial. *JAMA* 1984;**252**:2413–7.
22. Naithani S, Gulliford M, Morgan M. Patients' perceptions and experiences of 'continuity of care' in diabetes. *Health Expect* 2006;**9**:118–29.
23. Agarwal G, Crooks VA. The nature of informational continuity of care in general practice. *Br J Gen Pract* 2008;**58**:e17–e24.
24. Gill JM. Can hospitalizations be avoided by having a regular source of care? *Fam Med* 1997;**29**:166–71.
25. Overland J, Yue DK, Mira M. Continuity of care in diabetes: to whom does it matter? *Diabetes Res Clin Pract* 2001;**52**:55–61.