

Patients With Diabetes in Pay-for-Performance Programs Have Better Physician Continuity of Care and Survival

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Diabetes is a common chronic metabolic disease with increasing prevalence.¹ The strategies to improve diabetes care include optimizing the behavior of health providers, supporting patient behavioral adaptations, and changing the system of care.² With the increasing number of patients with diabetes, the provision of high-quality and cost-effective care for these patients has become an important but difficult task for healthcare providers.³ The healthcare systems of many countries have implemented pay-for-performance (P4P) programs to improve the quality of care. To improve patient outcomes, a P4P program provides financial rewards to healthcare providers who achieve pre-established criteria for treating specific diseases.⁴

In Taiwan, the National Health Insurance (NHI) Administration implemented its diabetes P4P program in 2001. Physicians whose specialties were internal medicine, pediatrics, family medicine, metabolism and endocrinology, cardiology, or nephrology were allowed to voluntarily participate.⁵ The P4P program provides financial incentives with additional reimbursements, which include increasing physician fees and case management fees to the participating physicians. In this program, quality performance is monitored by 4 indicators—each representing 25% of total achievement—that include the rates of patients: 1) who completed regular follow-ups (at least 3 visits per year), 2) whose glycated hemoglobin (A1C) was lower than 7%, 3) whose A1C was higher than 9.5%, and 4) whose low-density lipoprotein (LDL) was higher than 130 mg/dL. The achievement rate of each indicator was then summed and became the final achievement grade. Physicians were ranked according to this final achievement. Physicians can receive additional bonuses if they are ranked in the top 25% of their peers.⁶ Under this program, physicians are required to keep their P4P participants in follow-up at their clinic. If the P4P participants change doctors, the physician bonuses will be decreased or cancelled.

Taiwan's NHI program has no strict referral system; patients can go to any hospital or see any doctor of any subspecialty. However, changing physicians frequently seems to result in adverse outcomes. McAlister et al found that the mortality risk of patients

ABSTRACT

OBJECTIVES: This study investigated the effects of physician continuity, measured as the Continuity of Care Index (COCI) score, on the survival of patients with diabetes, including both pay-for-performance (P4P) participants and nonparticipants.

STUDY DESIGN: This was a retrospective, nationwide population-based analysis of 396,838 patients with diabetes, with 198,419 subjects each in the P4P participant and nonparticipant groups, from 1997 to 2009, in Taiwan.

METHODS: The data presented in this study are secondary data obtained from the 1997 to 2009 National Health Insurance Research Database published by the Taiwan National Health Research Institute. Survival status and physician continuity were the dependent variables. Multiple regression analysis was used to examine the factors related to physician continuity among patients with diabetes. The Cox proportional hazard model was used to explore the related factors that affected the survival status of the patients with diabetes.

RESULTS: After controlling for the other related factors, the COCI score of the P4P participants was 0.227 higher than that of the nonparticipants ($P < .05$). Compared with patients with a low COCI score ($\leq 50\%$), the hazard ratio (HR) of mortality of patients with a high COCI score ($> 50\%$) was 0.47 [95% confidence interval [CI], 0.46–0.48]. Compared with nonparticipants, the HR of mortality of P4P participants was 0.43 [95% CI, 0.41–0.44].

CONCLUSIONS: Patients with diabetes with higher physician continuity had a lower HR of mortality. P4P participants had higher physician continuity and a lower HR of mortality.

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TAKE-AWAY POINTS

- ▶ Diabetes pay-for-performance programs had higher physician continuity of care.
- ▶ Patients with diabetes with higher physician continuity had lower mortality.
- ▶ For other chronic diseases, such as hypertension or obesity, pay-for-performance programs can be applied and might also increase patients' physician continuity and survival.

with heart failure was lower among those who visited familiar physicians.⁷ Younge et al found that in patients with diabetes, a lower modified Continuity of Care Index (COCI) score was associated with poorer A1C control and a higher modified COCI score was associated with better LDL control.⁸ Physician continuity is also a factor related to lower healthcare costs. De Maeseneer et al found that patients visiting the same family physician had lower total medical costs.⁹ In a diabetes P4P program, there should be many factors, including physician continuity, that would have an effect on the clinical outcomes and survival of treated patients; however, to our knowledge, no papers have discussed this topic until now.

This study was designed to investigate factors that influence the participation of patients with diabetes in the P4P program. The objectives of the study are to explore the differences in physician continuity of care and survival between diabetes P4P participants and nonparticipants and to investigate the related factors influencing physician continuity of care and survival among diabetes P4P participants.

METHODS

Data Source and Research Subjects

The data presented in this retrospective study are secondary data obtained from the 1997 to 2009 NHI Research Database published by the National Health Research Institute. The study population included only patients newly diagnosed with type 2 diabetes between 2001 and 2009. Such a patient was defined as one hospitalized a minimum of 1 time or who was diagnosed with diabetes (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] code 250.x or A181) a minimum of 3 times at outpatient visits within 365 consecutive days (including both the primary and secondary diagnosis).¹⁰ Patients with gestational diabetes (ICD-9-CM code 648.0 or 648.8), neonatal diabetes (ICD-9-CM code 775.1), or impaired glucose tolerance (ICD-9-CM code 790.2) were excluded. A total of 1,179,862 patients were included in the study. The medical records of the follow-up outpatient visits of patients who had participated in the P4P program were reviewed and the specific treatment code E4 (P4P program for diabetes) was used as an indicator for these patients. Patients with diabetes who did not participate in the program for a minimum of half a year (26 weeks) were also excluded from the study.

In addition, personal factors and hospital policy could affect the participation of patients with diabetes in the P4P program, and thus, selection bias might occur.¹¹ We adopted the following method to reduce selection bias between patients with diabetes who had or had not participated in the program. This method had been widely used in studies based

on the Taiwan NHI database.^{12,13} The propensity score-matching method was used to collect a total of 396,830 research samples in 1:1 matching for further analysis based on personal characteristics (ie, gender and age), income (ie, monthly salary), severity of comorbidity (ie, Charlson Comorbidity Index [CCI] score¹⁴), severity of diabetes (Diabetes Complications Severity Index [DCSI] score¹⁵), and the characteristics of the healthcare organizations (ie, accreditation level and ownership).

Definitions of Variables and Method of Measurement

Two dependent variables were included in the study. The first was the survival status of the patients. Based on death certificate records, insurance withdrawal dates are the same as death dates. Taiwan's NHI is a compulsory single-payer program and there are only 3 conditions for people being withdrawn from NHI coverage: those who have been jailed for more than 2 months, have been legally missing for more than 6 months, or have died. Death was defined as being withdrawn from the NHI coverage within 30 days of hospital admission; this definition of mortality has been widely used in research based on Taiwan's NHI data.¹⁶⁻¹⁸

The second variable was physician continuity of care, which was measured as the COCI score.¹⁹ This index measures the distribution of clinical visits between physicians; a value between 0 and 1 was assigned to each patient. The closer the value was to 1, the higher the degree of continuity of care; a COCI score of 1 suggested that the same physician was seen by the patient at each outpatient visit. The index offered the advantage of being able to consider multiple physicians; the equation for the index is given below:

$$\text{COCI} = \frac{\sum_{i=0}^M n_i^2 - N}{N(N-1)}$$

N = number of medical visits per patient
 n_i = number of visits to physician _i per patient
 M = total number of physicians visited

The independent variables consisted of 5 categories. The first was the personal characteristics of the research patients, including gender, age, and monthly salary. The second was the environmental factor. We used the degree of urbanization, categorized into 7 levels, to reflect the characteristics of the residential area. Level 1 indicated the highest degree of urbanization and level 7 represented the lowest.²⁰ The third variable was health condition, including the severity of comorbidities and of the complications of diabetes. Severity of comorbidities was determined based on Deyo's methodology, in which the primary and secondary ICD-9-

CM diagnosis codes of the patients were converted into weighted numerical scores (using 1, 2, 3, and 6 points, respectively) and the weighted scores were summed to become the CCI score.¹⁴ The diabetes-related chronic complications of the CCI were not included in the CCI score to avoid duplication of the diseases already included in the DCSI score.¹³ The severity of complications of diabetes was determined according to the DCSI published by Young et al.¹⁵ This methodology includes the following complications of diabetes: diabetic retinopathy, nephropathy, neuropathy, cerebrovascular disease, cardiovascular diseases, peripheral vascular diseases, and endocrine complications. The primary and secondary ICD-9-CM diagnosis codes of these complications were then converted into numbers, which were summed and became the DCSI score (ranging from 0 [low] to 13 [high]). The fourth variable was characteristics of the primary physicians, represented by the physicians' annual service volume: high (>75%), medium (25%-75%), and low (<25%), using the quartile method before being subjected to analysis. The fifth was characteristics of the primary healthcare organizations, including their level and ownership.

Data Analysis

SAS version 9.3 (SAS Institute, Cary, North Carolina) was used to process and analyze the data. The research patients were divided into those who had and had not participated in the P4P program. The differences in each independent variable of the 2 groups are presented using percentages, mean, and standard deviation. Moreover, the χ^2 test was used to analyze whether there were significant differences in personal characteristics, health conditions, environmental factors, characteristics of primary physicians, and characteristics of major healthcare organizations between the 2 groups. Multiple regression analysis was used to examine the related factors of physician continuity of care in patients with diabetes. The Cox proportional hazard model was used to explore the related factors that affected the survival status of the patients with diabetes. This study was approved by the China Medical University Institutional Review Board.

RESULTS

A total of 396,838 subjects were included in this study, with 198,419 subjects in each group. After matching, all variables, including gender, age, monthly salary, CCI score, DCSI score, and level and ownership of healthcare organizations, revealed no significant differences between the 2 groups (Table 1).

We divided the patients into subgroups based on gender, age, monthly salary, level of residential urbanization, CCI score, DCSI score, physician's annual service volume, level and ownership of healthcare organizations, and diabetes duration. In each subgroup, the mean COCI score of the P4P participants (0.57 to 0.67) was significantly higher than that of the nonparticipants (0.17 to 0.50),

meaning that P4P participants had higher physician continuity. Detailed data are shown in Table 2.

In the multiple regression analysis, controlling for the other related factors, the COCI score of the P4P participants was 0.227 higher than that of the nonparticipants ($P < .05$). After controlling for other factors, the trend indicated that patients with diabetes who were treated by physicians with a higher annual service volume had higher COCI scores. Compared with patients treated by physicians with a low annual service volume, the COCI score of patients treated by physicians with a medium or high annual service volume was higher by 0.096 ($P < .05$) and 0.193 ($P < .05$), respectively. Compared with female patients, the COCI score of male patients was lower by 0.010 ($P < .05$). Patients with diabetes living in urbanization level 6 and 7 areas had lower COCI scores (0.009 lower; $P < .05$). Patients with higher CCI or DCSI scores tended to have lower COCI scores. Compared with the patients whose CCI scores were 0 to 1, patients with a higher CCI score had a COCI score 0.020 to 0.085 lower ($P < .05$). Compared with patients whose DCSI was 0 to 1, the COCI scores of patients with DCSI 2 or greater than or equal to 3 were 0.030 ($P < .05$) and 0.042 ($P < .05$) lower, respectively. In addition, compared with patients treated at medical centers, patients who were treated at clinics had higher COCI scores (0.062 higher; $P < .05$). The COCI scores of patients treated at nonpublic hospitals were 0.003 lower ($P < .05$) than those of patients treated at public hospitals. Patients with a longer diabetes duration tended to have lower COCI scores; compared with those whose diabetes duration was less than 3 years, patients with a longer diabetes duration had a COCI score 0.012 to 0.015 lower ($P < .05$). Details on the data are shown in Table 3.

Compared with patients with low COCI scores, the hazard ratio (HR) of mortality of patients with high COCI scores was 0.47 and the 95% confidence interval (CI) was between 0.46 and 0.48. Compared with P4P nonparticipants, the HR of mortality of P4P participants was 0.43 (95% CI, 0.41-0.44). Male patients showed a higher HR of mortality of 1.75 (95% CI, 1.71-1.80) compared with female patients. All of the following categories of patients tended to have lower HRs of mortality: those who were younger, had higher salaries, lived in areas of higher urbanization, or were treated by physicians with a higher annual service volume. The HRs of mortality of patients who were treated at regional hospitals, district hospitals, and clinics were 0.90 (95% CI, 0.87-0.93), 0.81 (95% CI, 0.78-0.84), and 0.58 (95% CI, 0.56-0.60), respectively, compared with patients who were treated at medical centers. The HR of mortality of patients who were treated at nonpublic hospitals was 1.16 (95% CI, 1.13-1.19) compared with that of patients treated at public hospitals. Compared with patients whose CCI score was 0 to 1, those higher CCI scores had high HRs of mortality, 1.10 to 2.12 ($P < .05$). Compared with patients whose DCSI was 0 to 1, the HRs of mortality of patients with DCSI 2 or ≥ 3 were 1.47 (95% CI, 1.43-1.52) and 1.65 (95% CI, 1.60-1.71), respectively. Detailed data are shown in Table 4.

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TABLE 1. Comparisons of Study Subjects after Propensity Score Matching for P4P Participation Status

Variables	After 1:1 Matched						P
	Total		Non-P4P		P4P		
	N	%	N	%	N	%	
Total	396,838	100.00	198,419	50.00	198,419	50.00	
Gender							.901
Female	188,026	47.38	93,993	47.37	94,033	47.39	
Male	208,812	52.62	104,426	52.63	104,386	52.61	
Age, years							.939
<35	16,401	4.13	8143	4.10	8258	4.16	
35-44	51,689	13.03	25,790	13.00	25,899	13.05	
45-54	115,497	29.10	57,767	29.11	57,730	29.09	
55-64	109,317	27.55	54,695	27.57	54,622	27.53	
65-74	74,119	18.68	37,086	18.69	37,033	18.66	
≥75	29,815	7.51	14,938	7.53	14,877	7.50	
Monthly salary (NT\$)							.975
Low-income households	3828	0.96	1884	0.95	1944	0.98	
≤17,280	26,081	6.57	13,042	6.57	13,039	6.57	
17,281-22,800	202,842	51.11	101,451	51.13	101,391	51.10	
22,801-28,800	75,745	19.09	37,894	19.10	37,851	19.08	
28,801-36,300	25,250	6.36	12,594	6.35	12,656	6.38	
36,301-45,800	31,755	8.00	15,861	7.99	15,894	8.01	
≥45,801	31,337	7.90	15,693	7.91	15,644	7.88	
CCI score							.968
0-1	83,009	20.92	41,422	20.88	41,587	20.96	
2-3	102,462	25.82	51,222	25.82	51,240	25.82	
4-6	117,787	29.68	58,956	29.71	58,831	29.65	
7-9	62,624	15.78	31,348	15.80	31,276	15.76	
≥10	30,956	7.80	15,471	7.80	15,485	7.80	
DCSI score							.706
0-1	312,301	78.70	156,255	78.75	156,046	78.64	
2	50,089	12.62	24,997	12.60	25,092	12.65	
≥3	34,448	8.68	17,167	8.65	17,281	8.71	
Level of hospital							.957
Medical center	64,222	16.18	32,152	16.20	32,070	16.16	
Regional hospital	142,594	35.93	71,328	35.95	71,266	35.92	
District hospital	77,359	19.49	38,680	19.49	38,679	19.49	
Clinic	112,663	28.39	56,259	28.35	56,404	28.43	
Ownership of hospital							.727
Public	95,261	24.01	47,583	23.98	47,678	24.03	
Nonpublic	30,1577	75.99	150,836	76.02	150,741	75.97	

CCI indicates Charlson Comorbidity Index; DCSI, Diabetes Complications Severity Index; NT\$, new Taiwan dollar; P4P, pay-for-performance.

The survival curve of patients with diabetes is shown in the **Figure**. The cumulative survival rate was highest in P4P participants with high COCI scores, followed by P4P nonparticipants with

high COCI scores, P4P participants with low COCI scores, and P4P nonparticipants with low COCI scores. For either P4P participants or P4P nonparticipants, the cumulative survival rate of patients

with high COCI scores was greater than that of patients with low COCI scores. In both high COCI and low COCI groups, the cumulative survival rate of P4P participants was higher than that of P4P nonparticipants (Figure).

DISCUSSION

In the Taiwanese P4P program, additional bonuses are given to physicians if their performance quality is ranked in the top quarter of their peers or if they maintain regular follow-up of their patients at their clinics. To achieve these goals, physicians should try to retain their P4P participants by providing good service, maintaining a high quality of diabetes treatment, and lowering the related treatment complications of the patients. If the patients are followed by the same physician, with regular serial laboratory and clinical records, the physician can more easily check each patient's general condition and modify treatment methods as necessary, which can subsequently improve treatment quality. With improved treatment quality and outcome, patients are more likely to trust their doctors and are less likely to change physicians.

Mainous et al found that better trust between physicians and patients was associated with higher physician continuity.²¹ This then becomes a virtuous cycle in which physicians can keep patients by improving treatment outcome and patients tend to consult with the same doctors because of the stable blood sugar control they experience. This might be the main reason that the P4P participants had significantly higher physician continuity than the nonparticipants.

Some patients suffered not only from diabetes, but also other chronic diseases, such as hypertension, hyperlipidemia, coronary artery disease, and chronic kidney disease. These patients had higher CCI scores and were more likely to take multiple drugs to control their diseases. In addition, some patients suffered from diabetic complications, such as diabetic retinopathy, diabetic nephropathy, diabetic neuropathy, or diabetic foot pain; additional medication or even surgery may be indicated for patients with a higher DCSI

TABLE 2. Relationship between P4P Participation Status and Patient Characteristics in Diabetic Continuity of Care

Variables	COCI						
	Non-P4P			P4P			P
	N	Mean	SD	N	Mean	SD	
Total	198,419	0.31	0.39	198,419	0.62	0.32	<.001
Gender							
Female	93,993	0.31	0.39	94,033	0.62	0.32	<.001
Male	104,426	0.31	0.39	104,386	0.62	0.33	<.001
Age, years							
<35	10,516	0.27	0.38	10,100	0.61	0.33	<.001
35-44	30,346	0.33	0.39	30,915	0.62	0.32	<.001
45-54	61,552	0.35	0.40	62,342	0.63	0.32	<.001
55-64	50,945	0.32	0.39	51,300	0.63	0.32	<.001
65-74	32,992	0.28	0.38	33,109	0.62	0.32	<.001
≥75	12,068	0.17	0.33	10,653	0.60	0.33	<.001
Average age, years: mean ± SD	55.14 ± 12.89			54.92 ± 12.33			<.001
Monthly salary (NT\$)							
Low-income households	1884	0.22	0.35	1944	0.61	0.34	<.001
≤17,280	13,042	0.30	0.39	13,039	0.62	0.32	<.001
17,281-22,800	101,451	0.32	0.39	101,391	0.62	0.32	<.001
22,801-28,800	37,894	0.29	0.38	37,851	0.61	0.33	<.001
28,801-36,300	12,594	0.32	0.39	12,656	0.63	0.32	<.001
36,301-45,800	15,861	0.33	0.39	15,894	0.64	0.32	<.001
≥45,801	15,693	0.33	0.39	15,644	0.63	0.32	<.001
Urbanization of residence area							
Level 1	56,489	0.31	0.39	54,393	0.62	0.32	<.001
Levels 2 and 3	91,038	0.32	0.39	90,771	0.63	0.32	<.001
Levels 4 and 5	33,541	0.30	0.39	36,650	0.62	0.32	<.001
Levels 6 and 7	17,351	0.30	0.38	16,605	0.60	0.32	<.001
CCI score							
0-1	41,422	0.37	0.40	41,587	0.65	0.32	<.001
2-3	51,222	0.34	0.40	51,240	0.63	0.32	<.001
4-6	58,956	0.30	0.39	58,831	0.62	0.32	<.001
7-9	31,348	0.26	0.37	31,276	0.60	0.32	<.001
≥10	15,471	0.22	0.35	15,485	0.57	0.33	<.001
DCSI score							
0-1	156,255	0.33	0.39	156,046	0.63	0.32	<.001
2	24,997	0.26	0.37	25,092	0.60	0.33	<.001
≥3	17,167	0.22	0.35	17,281	0.58	0.33	<.001
Physician's annual service volume							
Low	96,709	0.25	0.37	2155	0.56	0.32	<.001
Medium	88,590	0.35	0.40	110,125	0.59	0.32	<.001
High	13,120	0.50	0.41	86,139	0.66	0.32	<.001

(continued)

CLINICAL

TABLE 2. Relationship between P4P Participation Status and Patient Characteristics in Diabetic Continuity of Care (*continued*)

Variables	COCI						P
	Non-P4P			P4P			
	N	Mean	SD	N	Mean	SD	
Level of hospital							
Medical center	32,152	0.31	0.39	32,070	0.64	0.32	<.001
Regional hospital	71,328	0.28	0.38	71,266	0.64	0.32	<.001
District hospital	38,680	0.28	0.37	38,679	0.59	0.32	<.001
Clinic	56,259	0.38	0.40	56,404	0.61	0.32	<.001
Ownership of hospital							
Public	47,583	0.30	0.38	47,678	0.63	0.32	<.001
Nonpublic	150,836	0.32	0.39	150,741	0.62	0.32	<.001
Diabetes duration							
≤3 years	62,700	0.28	0.40	69,944	0.67	0.34	<.001
4-6 years	80,311	0.33	0.39	80,005	0.60	0.31	<.001
≥7 years	55,408	0.32	0.38	48,470	0.58	0.30	<.001

CCI indicates Charlson Comorbidity Index; COCI, continuity of care index; DCSI, Diabetes Complications Severity Index; NT\$, new Taiwan dollar; P4P, pay-for-performance; SD, standard deviation.

TABLE 3. Related Factors Affecting Continuity of Care in Patients With Diabetes

Variables	Unadjusted Model			Adjusted Model		
	β	SE	P	β	SE	P
P4P participating status						
No (ref)	–	–	–	–	–	–
Yes	0.310	0.001	<.001	0.227	0.001	<.001
Gender						
Female (ref)	–	–	–	–	–	–
Male	–0.001	0.001	.319	–0.010	0.001	<.001
Age, years						
<35 (ref)	–	–	–	–	–	–
35-44	0.041	0.003	<.001	0.039	0.003	<.001
45-54	0.048	0.003	<.001	0.052	0.003	<.001
55-64	0.039	0.003	<.001	0.052	0.003	<.001
65-74	0.009	0.003	.003	0.035	0.003	<.001
≥75	–0.062	0.004	<.001	–0.015	0.003	<.001
Monthly salary (NT\$)						
Low-income households (ref)	–	–	–	–	–	–
≤17,280	0.042	0.007	<.001	0.024	0.006	<.001
17,281-22,800	0.049	0.006	<.001	0.038	0.006	<.001
22,801-28,800	0.028	0.006	<.001	0.021	0.006	<.001
28,801-36,300	0.058	0.007	<.001	0.042	0.006	<.001
36,301-45,800	0.063	0.007	<.001	0.046	0.006	<.001
≥45,801	0.058	0.007	<.001	0.043	0.006	<.001

(*continued*)

score. Because of their more complicated medical conditions and possible drug interactions, patients with higher CCI or DCSI scores may be more likely to experience poor diabetes control. In such situations, patients might seek other physicians to get second opinions or better treatment. Whenever patients believe that their diseases are not well controlled or treated, they can easily consult other doctors without referral because Taiwan has no strict referral system. This might be why patients with diabetes with higher CCI or DCSI scores—both P4P participants and non-participants—had lower physician continuity.

In Taiwan, most patients prefer well-known doctors who usually have a higher service volume. This situation exists generally in Taiwan, not just in diabetes care: physicians with the best reputations attract more patients, then have higher service volumes. It is believed that these physicians have more clinical experience, better service, and better treatment outcomes. It is possible that treatment by these physicians is a guarantee of professional treatment and complete cure, so they are happy to spend much more time or pay higher service fees to consult them. These may be the reasons that both P4P participants and P4P nonparticipants who were treated by physicians with high annual service volumes had higher physician continuity.

Most patients with stable diabetes usually need just regular checkups and drug prescriptions. Family physicians in clinics can provide better healthcare accessibility and availability, so it is very convenient for such patients to be treated and followed up there. If patients' blood sugar levels become unstable, however, they may seek specialists, who they believe to be more professional, at medical centers or regional hospitals. Once their blood sugar stabilizes, they may again prefer to be treated and followed up at clinics because of convenience and shorter waiting time. In addition, stable patients with diabetes treated at clinics usually have fewer complications, such as emergency department (ED) visits, and, thus, the patients are willing to be treated at clinics.²² These may be the reasons that patients who were treated at clinics had higher physician continuity.

McAlister et al found that high physician continuity could reduce adverse outcomes among patients with heart failure.⁷ High physician continuity has been associated with lower likelihoods of admission to the ED²³ and hospitalization²⁴ and with having guideline-consistent care.²⁵ These factors should have similar effects on patients with diabetes. Patients with high COCI scores were generally followed up by a single doctor, and in these cases, physicians were familiar with the patients' general condition and could provide more effective and efficient treatment. These might be the reasons that patients with high COCI scores had higher survival.

Our data show that the HR of mortality increased as patients became elderly. People of advanced age usually have a higher likelihood of suffering from cancer or chronic diseases. Even upper respiratory infection could cause the death of an elderly person due to complications. Associated diseases or complications and poor drug adherence may result in poor diabetes control among senior patients.²⁶ These factors might lead to a higher mortality rate among the elderly.

This study showed the HR of mortality was higher in patients with lower monthly income. Social gradients and the resultant healthcare inequalities are the main problems in the US healthcare system²⁷ and in other countries, including Taiwan. Multiple factors influence this situation, including patient–physician communication, culture, social support and integration, and accessibility of healthy foods and places to exercise.²⁷ For these reasons, patients with a lower monthly salary might have an inferior lifestyle, poor control of disease, and higher risk of mortality.

Yu et al found that patients with diabetes with higher CCI or DCSI scores had a higher HR of ED visits for hypoglycemia.²² Further, Young et al found that a higher DCSI score indicated a higher risk of hospitalization and mortality among patients with diabetes.¹⁵ Some patients with diabetes may suffer from other chronic diseases and subsequently have higher CCI scores; additionally, patients with higher DCSI scores have variable diabetic-related complications and may experience poor blood sugar control. Either a high CCI or DCSI score may result in difficulty in diabetes control or more complications, leading to increased risk of mortality among such patients.

TABLE 3. Related Factors Affecting Continuity of Care in Patients With Diabetes (continued)

Variables	Unadjusted Model			Adjusted Model		
	β	SE	P	β	SE	P
Urbanization of residence area						
Level 1 (ref)	–	–	–	–	–	–
Levels 2 and 3	0.010	0.001	<.001	0.012	0.001	<.001
Levels 4 and 5	0.004	0.002	.060	0.003	0.002	.122
Levels 6 and 7	–0.018	0.002	<.001	–0.009	0.002	<.001
CCI score						
0-1 (ref)	–	–	–	–	–	–
2-3	–0.024	0.002	<.001	–0.020	0.002	<.001
4-6	–0.049	0.002	<.001	–0.040	0.002	<.001
7-9	–0.078	0.003	<.001	–0.060	0.002	<.001
≥10	–0.114	0.003	<.001	–0.085	0.003	<.001
DCSI score						
0-1 (ref)	–	–	–	–	–	–
2	–0.048	0.002	<.001	–0.030	0.002	<.001
≥3	–0.076	0.002	<.001	–0.042	0.002	<.001
Physician's annual service volume						
Low (ref)	–	–	–	–	–	–
Medium	0.224	0.001	<.001	0.096	0.002	<.001
High	0.376	0.002	<.001	0.193	0.002	<.001
Level of hospital						
Medical center (ref)	–	–	–	–	–	–
Regional hospital	–0.011	0.002	<.001	–0.005	0.002	.001
District hospital	–0.036	0.002	<.001	–0.009	0.002	<.001
Clinic	0.026	0.002	<.001	0.062	0.002	<.001
Ownership of hospital						
Public (ref)	–	–	–	–	–	–
Nonpublic	0.006	0.001	<.001	–0.003	0.001	.011
Diabetes duration						
≤3 years (ref)	–	–	–	–	–	–
4-6 years	–0.023	0.001	<.001	–0.012	0.001	<.001
≥7 years	–0.043	0.002	<.001	–0.015	0.001	<.001

CCI indicates Charlson Comorbidity Index; DCSI, Diabetes Complications Severity Index; NT\$, new Taiwan dollar; P4P, pay-for-performance; ref, reference; SE, standard error.

Yu et al found that the overloading of physicians might worsen treatment quality.²² Physicians with an excessively high service volume may be too busy to provide adequate patient education and treatment integration, which may lower the quality of care, clinical outcomes, and survival, thus possibly indicating why patients treated by physicians with high annual service volumes had higher HRs of mortality.

Although being treated at a clinic is associated with higher physician continuity, any patient—especially with multiple diseases—can

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TABLE 4. The Effects of Continuity of Care and P4P Participation Status on Mortality of Patients With Diabetes and Associated Factors

Variables	Survival		Dead		P	Adjusted Model			
	N	%	N	%		HR	95% CI		P
Total	365,358	92.07	31,480	7.93					
COCI					<.001				
Low (≤50%) (ref)	174,627	88.01	23,786	11.99		1	–	–	–
High (>50%)	190,731	96.12	7694	3.88		0.47	0.46	0.48	<.001
P4P participating status					<.001				
No (ref)	175,337	88.37	23,082	11.63		1	–	–	–
Yes	190,021	95.77	8398	4.23		0.43	0.41	0.44	<.001
Gender					<.001				
Female (ref)	176,209	93.72	11,817	6.28		1	–	–	–
Male	189,149	90.58	19,663	9.42		1.75	1.71	1.80	<.001
Age, years					<.001				
<35 (ref)	19,983	96.93	633	3.07		1	–	–	–
35-44	58,688	95.80	2573	4.20		1.36	1.25	1.49	<.001
45-54	118,123	95.34	5771	4.66		1.55	1.43	1.69	<.001
55-64	95,379	93.28	6866	6.72		2.12	1.96	2.30	<.001
65-74	57,298	86.68	8803	13.32		3.70	3.41	4.02	<.001
≥75	15,887	69.92	6834	30.08		8.15	7.50	8.86	<.001
Average age, mean ± SD	54.29 ± 12.23		63.61 ± 13.83		<.001 ^a				
Monthly salary (NT\$)					<.001				
Low-income households (ref)	3271	85.45	557	14.55		1	–	–	–
≤17,280	24,169	92.67	1912	7.33		0.63	0.58	0.70	<.001
17,281-22,800	186,098	91.75	16,744	8.25		0.54	0.49	0.58	<.001
22,801-28,800	68,156	89.98	7589	10.02		0.56	0.51	0.61	<.001
28,801-36,300	23,877	94.56	1373	5.44		0.44	0.40	0.48	<.001
36,301-45,800	30,065	94.68	1690	5.32		0.40	0.36	0.44	<.001
≥45,801	29,722	94.85	1615	5.15		0.35	0.32	0.39	<.001
Urbanization of residence area					<.001				
Level 1 (ref)	103,973	93.77	6909	6.23		1	–	–	–
Levels 2 and 3	168,059	92.44	13,750	7.56		1.13	1.09	1.16	<.001
Levels 4 and 5	63,290	90.17	6901	9.83		1.27	1.23	1.32	<.001
Levels 6 and 7	30,036	88.46	3920	11.54		1.41	1.35	1.47	<.001
CCI score					<.001				
0-1 (ref)	79,296	95.53	3713	4.47		1	–	–	–
2-3	96,817	94.49	5645	5.51		1.10	1.05	1.15	<.001
4-6	108,415	92.04	9372	7.96		1.36	1.31	1.42	<.001
7-9	55,309	88.32	7315	11.68		1.67	1.60	1.74	<.001
≥10	25,521	82.44	5435	17.56		2.12	2.02	2.22	<.001
DCSI score					<.001				
0-1 (ref)	292,776	93.75	19,525	6.25		1	–	–	–
2	44,000	87.84	6089	12.16		1.47	1.43	1.52	<.001
≥3	28,582	82.97	5866	17.03		1.65	1.60	1.71	<.001

(continued)

TABLE 4. The Effects of Continuity of Care and P4P Participation Status on Mortality of Patients With Diabetes and Associated Factors (continued)

Variables	Survival		Dead		P	Adjusted Model			
	N	%	N	%		HR	95% CI	P	
Physician's annual service volume					<.001				
Low (ref)	87,649	88.66	11,215	11.34		1	–	–	–
Medium	183,290	92.24	15,425	7.76		1.08	1.05	1.11	<.001
High	94,419	95.12	4840	4.88		1.26	1.20	1.31	<.001
Level of hospital					<.001				
Medical center (ref)	58,658	91.34	5564	8.66		1	–	–	–
Regional hospital	130,290	91.37	12,304	8.63		0.90	0.87	0.93	<.001
District hospital	69,948	90.42	7411	9.58		0.81	0.78	0.84	<.001
Clinic	106,462	94.50	6201	5.50		0.58	0.56	0.60	<.001
Ownership of hospital					.981				
Public (ref)	87,702	92.06	7559	7.94		1	–	–	–
Nonpublic	277,656	92.07	23,921	7.93		1.16	1.13	1.19	<.001

CCI, Charlson Comorbidity Index; CI, confidence interval; COCI, continuity of care index; DCSI, Diabetes Complications Severity Index; HR, hazard ratio; NT\$, new Taiwan dollar; P4P, pay-for-performance; ref, reference; SD, standard deviation.
*t test.

directly visit doctors in medical centers and pay low co-payments under Taiwan's health insurance system. In addition, patients may be referred to medical centers due to multiple chronic diseases or diabetic complications. It is likely that patients treated at medical centers have higher CCI or DCSI scores, and these patients may have more comorbidities and complications and a higher risk of mortality.^{15,28}

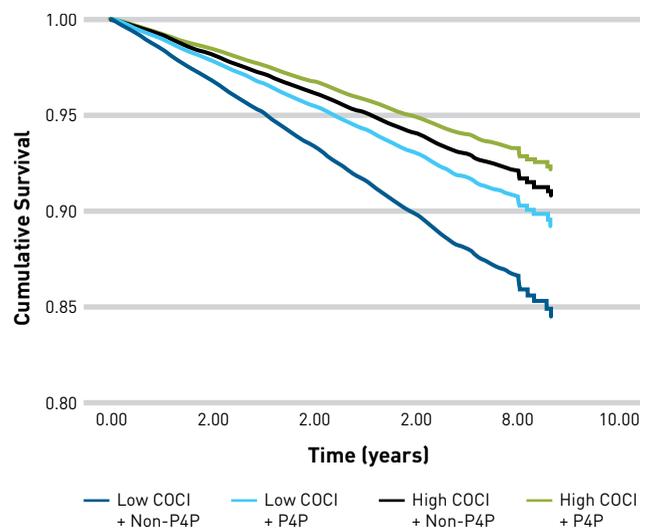
Limitations

First, the database contained claims data only, not laboratory results. It was impossible to confirm the relationship between diabetes severity and laboratory results. Second, many environmental factors may affect physician continuity and the survival of patients with diabetes; urbanization is only 1 of these factors. Third, the database did not have data on lifestyle, occupation, and family history. The effect of these factors on the patients could not be evaluated.

CONCLUSIONS

This study revealed that high physician continuity is correlated with a low HR of mortality in patients with diabetes, meaning that any health policy that increases patients' physician continuity might decrease mortality in some diseases. We demonstrated that diabetes P4P participants have higher physician continuity and a lower HR of mortality, showing that the P4P program is also an important policy, as it could increase survival or improve treatment outcomes in specific diseases, especially chronic diseases such as diabetes. Health policy makers should evaluate the possibility of P4P programs in treating other chronic diseases, such as hypertension or chronic kidney disease. ■

FIGURE. Survival Curve of Patients With Diabetes^{a,b}



COCI indicates continuity of care index; P4P, pay-for-performance.
^aThe cumulative survival rate of the P4P participants was higher than that of the nonparticipants in both the high-COCI and low-COCI groups.
^bThe cumulative survival rate of patients with high COCI scores was significantly higher than that of patients with low COCI scores among both the P4P participants and nonparticipants.

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