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ORIGINAL ARTICLE

Continuity of care trajectories and emergency room use among patients with diabetes

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Abstract
Objectives To analyze the pattern of continuity of care (COC) using trajectory analysis for a group of patients newly diagnosed with diabetes, and determine whether various trajectories lead to distinct patient outcomes.
Methods We used the Taiwan National Health Insurance claims database. Newly diagnosed patients with diabetes in 2005 totaling 4367 were included in this study. All patients were followed up to 2011. We identified groups of COC trajectories using trajectory analysis. We subsequently determined whether various COC trajectories were associated with the frequency of total and diabetes-related emergency room (ER) use using negative binomial models.
Results We discovered five distinct COC trajectories for our newly diagnosed diabetes sample based on trajectory analysis. The early-seeker group had the lowest IRR for total ER visits (IRR $= 0.56$, $P < 0.001$), followed by the high-maintainer group (IRR $= 0.67$, $P < 0.001$). Similar results were obtained for diabetes-specific ER use.
Conclusions We identified various COC trajectories for diabetes patients. Chronic disease patients may seek a suitable physician by compromising care continuity at the onset of disease progression and exhibit favorable outcome.

Keywords Continuity of care (COC) · Group-based trajectory analysis · Emergency room (ER) use · Diabetes

Introduction

Continuity of care (COC) has gained considerable attention in the past decade. COC is generally defined as the relationship between a single health provider and a patient, and the relation extends beyond the treatment of a particular disease episode (Hennen 1975). Studies have overwhelmingly reported a positive relationship between COC and patient outcome. These positive outcomes include a reduced rate of avoidable hospitalization (Menec et al. 2006; Cheng et al. 2010; Lin et al. 2010), reduced emergency department use (Christakis et al. 2001; Menec et al. 2005; Ionescu-Ittu et al. 2007; Chu et al. 2012), enhanced preventive health care (such as cancer screening) (Menec et al. 2005), and reduced medical care costs (De Maeseneer et al. 2003; Chen and Chen 2011). The primary argument concerning this relationship is that optimal COC encourages an optimal physician–patient relationship, thereby enabling deeper trust and effective communication (Lafferty et al. 2011), allowing the creation of a comprehensive patient medical history and instilling the physician with a sustained sense of responsibility (McWhinney 1975; Haggerty et al. 2003).

Chronic diseases have increasingly become a burden in many countries (Levesque et al. 2013; Maziak et al. 2013). COC is particularly crucial for patients with chronic diseases (Haggerty et al. 2003), such as diabetes mellitus (DM). Chronic diseases typically involve repeated visits for similar health conditions. However, studies on how patients with chronic diseases vary their COC after

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discovering the disease, and whether distinct COC trajectories are used by these patients, are rare. For example, a person may spend considerable time seeking the most suitable doctor before undertaking long-term treatment of the disease. “Suitable” may either mean a high-quality provider, or a person with whom the patient is most conformable with not considering quality. Studies have indicated that COC primarily leads to patient satisfaction, which is an indication of improved patient outcome (Guthrie and Wyke 2000). According to Kasteler et al. (1976), an individual may change doctors for four reasons including (1) lack of confidence in the physician, (2) dislike toward the physician, (3) dissatisfaction with system factors such as cost and waiting time, and (4) self-reliance or tendency to adopt the sick role. If patients change doctors for these reasons at the onset of chronic disease, patient outcome should not be negatively affected, provided that necessary treatments are not postponed.

Using a US sample of 1071 patients between 21 and 64 years of age, with employer-related health benefits, Harris (2003) discovered that 31 % of the sample patients seriously considered another physician before choosing their current physician, and approximately one-third of the patients expressed a willingness to switch physicians. In another study conducted in the USA, Tu and Lauer (2008) reported findings based on a nationally representative survey of 13,500 adults conducted in 2007, which indicated that more than one in ten adults reported that they looked for a new primary care physician during the 12 months prior to the survey, and they conducted this search primarily based on “word of mouth” and, in the case of specialists, physician referrals. However, despite studies on the reasons why patients switch physicians, studies on the manner in which patients switch doctors over time after a chronic disease episode occurs or the pattern of such changes are limited. Consequently, the benefits of seeking the most suitable doctor by sacrificing care continuity are unknown.

Taiwan implemented the National Health Insurance (NHI) program in 1995, which is compulsory for all Taiwan citizens. More than 96 % of the hospitals and 92 % of the clinics in Taiwan are contracted with the NHI program (Cheng et al. 2011). In Taiwan, patients can choose any physician or specialist at any level (medical centers, regional hospitals, district hospitals, or clinics) at any time without referral. The majority of outpatient and inpatient services are covered under NHI, and users are required to pay a minimum copayment (Cheng et al. 2011).

We analyzed the COC pattern using trajectory analysis for a group of patients who were newly diagnosed with type II diabetes, and determined whether various trajectories affect the probability of total and diabetes-specific emergency room (ER) use. We contended that certain patients who were newly diagnosed with chronic disease, such as patients with diabetes, may change doctors during the first few visits to find the most suitable doctor. Assuming that necessary treatments were not postponed, we hypothesized that those who changed doctors obtained excellent patient outcome, which was measured using the number of total and diabetes-related ER visits.

Methods

Data and study sample

We used the Taiwan NHI claims database organized by the National Health Research Institutes of Taiwan, which contained one million randomly chosen insurants enrolled in the NHI program in 2005. A person can be included into the sample even if the person did not visit their physician during the year. The Taiwan NHI program is a public insurance system in which the enrollment of all Taiwan citizens is compulsory. Thus, the 2005 database is representative of Taiwan’s population in 2005. All the insurants were followed longitudinally until 2011, and all claims data under the NHI can be obtained for this cohort.

Diabetes was defined using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9 CM) as ICD-9-CM 250.xx. Newly diagnosed patients with diabetes in 2005 were included in the study sample. To be included in the study, a person was required to fulfill the following three inclusion criteria in 2005: (1) the patient had no diabetes diagnosis prior to 2005 (to ensure that the included patients were only those who were newly diagnosed); (2) to ensure the patient had diabetes, the patient must have had at least two outpatient diabetes diagnoses, in addition to at least one prescription of diabetes pharmaceuticals in 2005, or at least one inpatient use of these pharmaceuticals with the primary diagnosis being diabetes; and (3) the patient had a minimum of five diabetes outpatient visits within the follow-up time since the first diabetes diagnosis in 2005. This criterion is necessary because COC is invalid with a limited number of visits, and such practice in COC studies is common (Chen and Chen 2011; Chen et al. 2013). Using these three inclusion criteria, we obtained 4363 newly diagnosed diabetes patients from 2005, who were included in the trajectory assignment analysis. Of the 4363 participants, 3781 were alive by the end of 2011 and included in the analysis for predicting total and DM-specific ER use in 2010 and 2011. The Institutional Review Board of National Yang-Ming University approved this study.

Measures

Exposure: continuity of care

Several measures of COC are available and are typically used to measure various dimensions. The COC index (COCI) has been widely used; it was used in the current study to maintain consistency with previous studies (Cheng et al. 2010; Cheng et al. 2011; Chen et al. 2013). For each patient, COC was operationalized as (Bice and Boxerman 1977):

$$COC = \left[\left(\sum_{i=1}^{p} n_i^2\right) - T\right] \Big/ T(T-1),$$

where T is the total number of diabetes-related outpatient visits, and a visit is defined as diabetes related if the physician used the ICD-9-CM 250.xx code for that particular visit; n_i is the number of times the patient visited a physician i; and p is the total number of physicians visited. The index value ranges from 0 to 1, with 0 indicating no continuity and 1 indicating perfect continuity. An outpatient visit was included in the COC calculation if the patient received a diagnosis of ICD-9 CM 250.xx and was prescribed at least one diabetes pharmaceutical during the same visit. We used only outpatient visits because inpatient use is more likely to be a COC outcome (Worrall and Knight 2011; Nyweide et al. 2013). We subsequently used a moving-average method to determine the COC level over time, with each average calculated using five physician visits. For example, the first COC was calculated using the first five diabetes physician visits, and the second COC using the second to sixth diabetes visits. Another option is to designate the unit of analysis as "time" instead of "visit." For example, COC can be calculated for a diabetes patient within a certain time frame, such as 1 year. Both methods have advantages and disadvantages. When calculating COC based on visits, we were unable to control for the uneven distribution of visits among the patients. However, using "time" as the unit of analysis will cause the problem of an unequal number of visits made by patients within a fixed period. In this scenario, the COC of the patients is not comparable. In addition, when using "time" as the unit of analysis, defining the time frame that should be used is difficult. For these reasons, we chose "visit" as the unit of analysis, because it should involve less bias compared with using "time" as the unit of analysis.

Within the 6-year span, the maximal COC score calculated for a single participant in this study sample was 63. Because no previous studies can be used as references, the number of visits was arbitrarily set to 5. To ensure that our study results were robust according to various specifications, we also tested COC, which was defined using four and six visits. The results were similar and, therefore, we retained only the results from five visits.

Outcome variable

We used two outcome variables: total number of ER visits and diabetes-specific user visits. A diabetes-specific ER visit was defined as an ER visit in which a diagnosis code for diabetes was assigned (ICD9-CM-250.xx). The frequency of visits that occurred in the final 2 years of the 6-year follow-up period (2010 and 2011) was defined as the outcome variable. We measured the outcome variable in the final 2 years of the data, because if a patient dies early after the onset of the disease, it is unlikely that the patient outcome is caused by the trajectory. For this reason, only patients who were alive by the end of 2011 were included in this part of the analysis. We used 2010 and 2011 (instead of only 2011) to obtain a reasonable number of participants who visited the ER. To be conservative, we also estimated a model that involved only ER use in 2011, and all explanatory factors exhibited similar signs and significance. Therefore, we presented only the models that defined ER use between 2010 and 2011.

Other variables

Diabetes severity

We assumed that the COC of a diabetes patient, as well as the probability of being hospitalized or visiting the ER, is influenced by diabetes severity. For example, a patient with severe diabetes may lose confidence in his/her physician and change physicians. We estimated the severity of diabetes using the Diabetes Complications Severity Index (DCSI), which is a measure of the number and type of diabetes complications. These complications include retinopathy, nephropathy, neuropathy, cerebrovascular disease, cardiovascular disease, peripheral vascular disease, and metabolic disease. A detailed description of the method used to construct this index can be found elsewhere (Young et al. 2008). DCSI has been demonstrated to be an excellent indicator of diabetes severity and provides accurate predictions of mortality and risk of hospitalization among diabetes patients (Young et al. 2008). DCSI changes were defined based on the DCSI score for 2011, minus the DSCI score for 2005. The patients were subsequently categorized as those with improved, unchanged, and worsened scores.

Charlson comorbidity score

The Charlson comorbidity index (CCI) score was calculated based on 19 disease categories (D'Hoore et al. 1996), excluding the two categories associated with diabetes (diabetes with and without end-organ damage). The reason for excluding these two categories is that they are collinear with DCSI. A person was considered as having a comorbid condition in a year if he or she had at least two claim records with an ICD-9 code for that condition during the year. A high score indicates a greater comorbidity. Similarly, CCI changes were defined as the CCI score for 2011, minus the CCI score for 2005. The patients were subsequently categorized into those with improved, unchanged, and worsened scores.

Demographic and socioeconomic variables

We also included the insurance income of patients as a variable in this study. Fishers and farmers do not have a clearly defined wage and, therefore, included in a separate group when constructing the income variable. Other variables included age, sex, area of residence, and site at which the patient was first diagnosed with diabetes (medical centers, regional hospitals, district hospitals, or clinics). This variable was included because a previous study demonstrated that regularly visiting a site of care is a significant determinant of continuity (Doescher et al. 2001), and, under a system without referral management, larger hospitals can be assumed to possess the capability of providing coordinated care and, thus, are highly likely to become a regularly visited site for patients seeking health care.

Statistical analysis

We focused on the relation between COC trajectories within the first 6 years since the first diagnosis of diabetes and the outcome variables (total and diabetes-related ER use). First, we identified groups of COC trajectories using trajectory analysis (Singer and Willett 2003), to estimate a discrete mixture model for longitudinal data grouping using censored normal distribution. Assignments to the group that optimally conformed to the observed COC were based on the maximal posterior probability of group membership. Models were selected based on the Bayesian information criteria (BIC). The model with the lowest BIC is balanced between parsimony and goodness of fit.

In the trajectory model, we controlled several factors that might affect the assignment of trajectories including the baseline variables of age, sex, income (proxies using the NHI insurable income), area, the DCSI, the CCI, and the type of medical institute in which the first diabetes outpatient visit occurred. Baseline DCSI and CCI were used instead of DCSI and CCI for each year, because they are measures of patient outcome and are likely to be the consequence of a health-care-seeking pattern rather than the cause of it. The reference group was the low-maintainer group.

We subsequently estimated negative binominal models (Anscombe 1948) to determine whether ER visits (all and diabetes specific) were affected by various COC trajectories. Negative binominal models were used to account for possible overdispersion of the data. In these models, we controlled for the baseline variables as well as changes in DCSI and CCI. Because the type of medical institute in which the first diabetes outpatient visit occurred should not be closely associated with ER use 5 years later, this variable was excluded from the models. All analyses were conducted using STATA 12 MP software, and the group-based trajectory model was estimated using the traj command.

Results

Figure 1 shows the assigned COC trajectories for the 4367 diabetes patients. Based on the trajectory model estimations, five trajectories represented the optimal balance between parsimony and goodness of fit. According to Fig. 1, we categorized the sample into five groups based on the trajectory model estimation: (1) high maintainers (COC started high and consistently remained high); (2) early seekers (COC started low and increased over a few visits); (3) late seekers (COC started low and increased after more visits than those made by the early seekers); (4) decliners (COC started high, but decreased over time), and (5) low maintainers (COC started low and consistently remained low over time). A slightly higher percentage of our sample was categorized as late seekers (23.8 %) compared with the other groups, and the high maintainers comprised the lowest percentage (17.5 %).

Table 1 presents the baseline sample characteristics of the patients by trajectory group, and Table 2 shows the

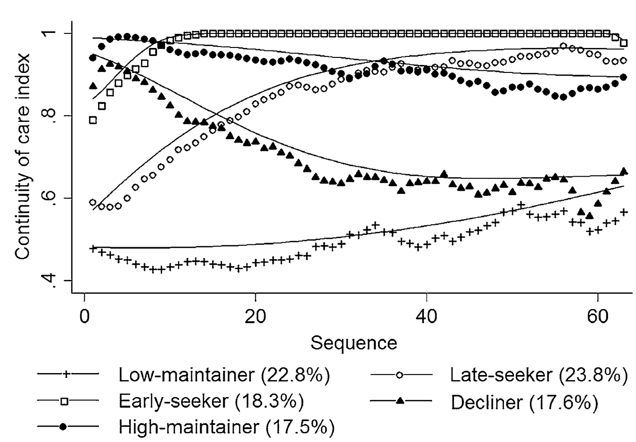

Fig. 1 Trajectories of care continuity, Taiwan (2005–2011)

Table 1 Baseline sample characteristics by trajectories, Taiwan 2005 ($n = 4367$)

	High maintainer		Early seeker		Late seeker		Decliner		Low maintainer		p value[a]
n	718		714		1124		700		1111		
Baseline age (mean)	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
20–40	60	8.4	68	9.5	69	6.1	64	9.1	131	11.8	<0.001
41–50	145	20.2	165	23.1	215	19.1	108	15.4	250	22.5	
51–65	258	35.9	294	41.2	462	41.1	311	44.4	429	38.6	
>65	255	35.5	187	26.2	378	33.6	217	31.0	301	27.1	
Sex (male)	356	49.6	413	57.8	596	53.0	341	48.7	651	58.6	<0.001
Income (NT$)											
<20,000	238	33.1	251	35.2	382	34.0	248	35.4	487	43.8	<0.001
20,000–39,999	201	28.0	140	19.6	261	23.2	199	28.4	217	19.5	
>=40,000	104	14.5	163	22.8	201	17.9	112	16.0	145	13.1	
Fishermen/farmers	175	24.4	160	22.4	280	24.9	141	20.1	262	23.6	
Area											
Taipei	200	27.9	242	33.9	484	43.1	254	36.3	259	23.3	<0.001
North	82	11.4	76	10.6	112	10.0	76	10.9	216	19.4	
Central	158	22.0	146	20.4	162	14.4	117	16.7	199	17.9	
South	106	14.8	114	16.0	174	15.5	126	18.0	180	16.2	
Kuo-Pin	149	20.8	121	16.9	140	12.5	115	16.4	228	20.5	
East	23	3.2	15	2.1	52	4.6	12	1.7	29	2.6	
Diabetes severity (DCSI)											
0	504	70.2	506	70.9	747	66.5	425	60.7	809	72.8	<0.001
1	118	16.4	126	17.6	183	16.3	122	17.4	190	17.1	
2	70	9.7	64	9.0	173	15.4	74	10.6	76	6.8	
>=3	26	3.6	18	2.5	21	1.9	79	11.3	36	3.2	
Charlson comorbidity index											
0	432	60.2	449	62.9	587	52.2	382	54.6	702	63.2	<0.001
1	177	24.7	178	24.9	321	28.6	181	25.9	280	25.2	
2	74	10.3	46	6.4	108	9.6	74	10.6	67	6.0	
>=3	35	4.9	41	5.7	108	9.6	63	9.0	62	5.6	
Change in DCSI											
Improved	120	16.7	103	14.4	237	21.1	173	24.7	206	18.5	<0.001
Unchanged	432	60.2	467	65.4	634	56.4	326	46.6	668	60.1	
Worsened	166	23.1	144	20.2	253	22.5	201	28.7	237	21.3	
Change in CCI											
Improved	181	25.2	166	23.2	334	29.7	175	25.0	266	23.9	0.019
Unchanged	374	52.1	394	55.2	560	49.8	351	50.1	577	51.9	
Worsened	163	22.7	154	21.6	230	20.5	174	24.9	268	24.1	
Level of first visit											
Medical center	96	13.4	125	17.5	222	19.8	164	23.4	111	10.0	<0.001
Regional hospital	207	28.8	184	25.8	324	28.8	178	25.4	185	16.7	
District hospitals	105	14.6	117	16.4	216	19.2	136	19.4	300	27.0	
Clinics	310	43.2	288	40.3	362	32.2	222	31.7	515	46.4	
Emergency room use (all)											
Mean	0.833	3.051	0.615	1.394	0.889	2.123	0.980	2.171	1.231	6.784	0.0193
Min	0		0		0		0		0		
Max	72		15		38		22		215		

Table 1 continued

	High maintainer		Early seeker		Late seeker		Decliner		Low maintainer		p value[a]
Emergency room use (DM)											
Mean	0.148	0.521	0.132	0.513	0.209	0.716	0.256	0.904	0.238	0.797	0.0013
Min	0		0		0		0		0		
Max	6		5		10		13		12		

[a] Chi squared for categorical variables and ANOVA for continuous variables

Table 2 Factors associated with trajectory group membership (reference: low maintainer), Taiwan 2005–2011

	High maintainer		Early seeker		Late seeker		Decliner	
	Estimates	p value	Estimates	p value	Estimates	p value	Estimates	p value
$n = 4367$								
Constant	−0.568	0.038	−0.077	0.765	0.176	0.500	−0.002	0.995
Baseline age								
20–40 (ref)								
41–50	0.184	0.424	0.181	0.405	0.233	0.300	−0.086	0.708
51–65	0.148	0.496	0.165	0.423	0.357	0.090	0.208	0.323
>65	0.445	0.052	0.135	0.542	0.286	0.204	0.166	0.460
Sex (ref = male)	0.254	0.028	0.051	0.651	0.166	0.134	0.283	0.015
Income (NT$)								
< 20,000 (ref)								
20,000–39,999	0.525	<0.001	0.109	0.472	0.193	0.188	0.420	0.005
>=40,000	0.245	0.165	0.382	0.017	0.131	0.430	0.192	0.268
Fishermen/farmers	0.220	0.155	0.166	0.278	0.227	0.126	0.064	0.689
Area								
Taipei (ref)								
North	−0.324	0.090	−0.533	0.004	−0.589	0.001	−0.489	0.009
Central	0.088	0.608	−0.052	0.752	−0.427	0.010	−0.268	0.122
South	−0.122	0.516	−0.234	0.193	−0.388	0.028	−0.175	0.336
Kuo-Ping	0.011	0.949	−0.345	0.039	−0.578	<0.001	−0.371	0.030
East	0.028	0.934	−0.546	0.142	−0.039	0.901	−0.623	0.104
Diabetes severity (DCSI)								
0 (ref)								
1	−0.098	0.528	−0.002	0.989	−0.009	0.950	0.048	0.751
2	0.112	0.609	0.148	0.492	0.228	0.264	0.259	0.222
>=3	0.111	0.730	−0.093	0.785	−0.305	0.370	0.609	0.037
Charlson comorbidity index								
0 (ref)								
1	−0.054	0.693	−0.025	0.850	0.148	0.252	0.046	0.740
2	0.183	0.430	−0.010	0.966	0.314	0.162	0.378	0.093
>=3	−0.210	0.459	0.049	0.852	0.184	0.472	0.083	0.750
Level of first visit								
Medical center (ref)								
Regional hospital	0.151	0.441	0.017	0.931	−0.091	0.623	−0.304	0.103
District hospitals	−0.708	<0.001	−0.626	0.001	−0.529	0.004	−0.828	<0.001
Clinics	−0.232	0.201	−0.286	0.100	−0.595	<0.001	−0.749	<0.001

estimates from the trajectory analysis for various factors associated with being assigned to a particular trajectory. The reference group was the low maintainers. Compared with being assigned as low maintainers, those with income of <NT$20,000 were significantly more likely to be assigned as high maintainers or decliners, and those with income of NT$20,000–39,999 were significantly more likely to be assigned as early seekers. Those with DCSI >2 were more likely to be assigned as decliners ($P = 0.037$). Charlson comorbidity was not significantly associated with the trajectories assigned. The type of medical institute in which the first diabetes diagnosis was made was significantly associated with trajectory assignment. Those who visited district hospitals and clinics were more likely to be assigned to the low-maintainer group than those who visited a medical center for the first visit, as indicated by the negative signs associated with district hospitals and clinics for the other four groups.

Table 3 shows the estimates from the negative binominal models. First, trajectories were significantly associated with both total ER and diabetes-specific ER visits. Compared with the low-maintainer group, the other four groups were less likely to visit the ER for non-DM-specific reasons, and the lowest IRR was observed for the early-seeker group (IRR = 0.56, $P < 0.001$). Similar results were obtained in the model of diabetes-specific ER visits. Compared with low maintainers, early seekers (IRR = 0.54, $P < 0.001$) and high maintainers (IRR = 0.63, $P = 0.006$) were significantly less likely to have diabetes-specific ER visits. When we changed the reference to early seekers (table not shown), the IRRs for the high-maintainer group were not significant, indicating that high maintainers had similar total and diabetes-specific ER use compared with early seekers.

The association between age and ER use was nonlinear. Those with an income of NT$20,000–39,999 were less likely to visit the ER for non-DM-specific reasons. None of the income dummies were statistically significant in the diabetes-specific ER visits model. As expected, those with worsened DCSI scores in 2011 were more likely to visit the ER for non-DM-specific reasons (IRR = 1.60, $P < 0.001$) and make diabetes-specific ER visits (IRR = 2.17, $P < 0.001$). Similar results were obtained when we analyzed changes in the CCI score.

Discussion

Prior examinations of the advantages of high COC on patient outcome have generally ignored distinct COC trajectories. This study produced two main findings: first, we determined that for a chronic disease such as diabetes, patients have distinct COC trajectories after the first diagnosis. Certain patients had lower care continuity for the first few visits after the first diabetes diagnosis, indicating the probability of searching for a suitable physician before undergoing long-term treatment of diabetes. Second, such COC trajectories are significantly associated with patient outcome, measured using total and diabetes-related ER use. Our hypothesis that early seekers would exhibit more favorable patient outcomes compared with that of patients from other trajectories was confirmed by our data, except that those in the high-maintainer group did not have a significantly different outcome compared with the early-seeker group. Our findings have important public health implications. High COC has always been emphasized to improve patient outcome. We contend that although high COC leads to favorable patient outcome, switching doctors in the first few visits is acceptable because it results in similar outcome compared with not switching doctors. This is particularly relevant to patients with chronic diseases that often require repeated visits. In some cases, encouraging patients with chronic diseases to change physicians for the purpose of seeking the most suitable physician may even be desirable if this improves patient satisfaction. For physicians, having patients with high satisfaction may lead to higher patient compliance, which in turn can also lead to superior patient outcome.

There are several plausible explanations for high maintainers having equally favorable outcome compared with early seekers. First, those belonging to the high-maintainer group could have possessed certain personal traits that could not be measured using our data. Second, although these patients did not seek suitable physicians at the early stages of diabetes progression through trial and error (consequently, they maintained a high COC at the onset of disease progression), they discovered a suitable physician either by chance or believed that the first physician was the most suitable and decided not to switch physicians. High physician continuity might also positively affect patient outcome, regardless of whether the physician was considered suitable. Harris (2003) observed that patients who give high ratings to a current physician are less willing to switch physicians despite poor quality than those who give low ratings to their current physician. Therefore, our results suggest that such behavior may be beneficial if optimal COC is maintained.

Our data also indicated that those who were first diagnosed at smaller medical institutions (district hospitals or clinics) were more likely to be assigned to the low-maintainer group (the group with the highest probability of non-DM-specific and diabetes-specific ER use) than those first diagnosed in larger medical institutions. Large hospitals, such as medical centers, are likely to provide coordinated care through a team of providers, which likely increases the possibility of visiting an optimal site and, therefore, increases the possibility of physician continuity.

Table 3 Multivariable negative binomial estimation for emergency room use, Taiwan 2010 and 2011

	All emergency room use		DM emergency room use	
$n = 3781$	IRR	p value	IRR	p value
Trajectories				
Low maintainer (ref)				
Late seeker (2)	0.81	0.015	0.94	0.655
Early seeker	0.56	<0.001	0.54	<0.001
Decliner	0.78	0.008	0.85	0.301
High maintainer	0.67	<0.001	0.63	0.006
Baseline age				
Ref = 20–40)				
41–50	0.72	0.004	0.60	0.011
51–65	0.66	<0.001	0.67	0.028
>65	0.80	0.047	0.80	0.248
Sex	1.01	0.912	1.09	0.399
Income (NT$)				
Ref: <20,000				
20,000–39,999	0.85	0.038	0.91	0.507
>=40,000	0.67	<0.001	0.82	0.200
Fishermen/farmers	0.98	0.789	0.98	0.872
Area				
Ref: Taipei				
North	0.91	0.333	1.01	0.942
Central	0.95	0.536	1.11	0.490
Central-south	0.82	0.039	0.85	0.335
South	0.90	0.233	0.96	0.788
East	1.11	0.540	1.01	0.962
Diabetes severity (DCSI)				
0 (ref)				
1	1.15	0.142	1.24	0.174
2	1.31	0.026	1.30	0.215
>=3	1.28	0.200	1.49	0.230
Charlson comorbidity index				
0 (ref)				
1	2.31	<0.001	2.02	<0.001
2	2.67	<0.001	2.08	0.001
>=3	4.83	<0.001	3.11	<0.001
Change in DCSI				
Improved (ref)				
Unchanged	1.00	0.994	1.03	0.898
Worsened	1.60	<0.001	2.17	<0.001
Change in CCI				
Improved (ref)				
Unchanged	1.99	<0.001	1.91	<0.001
Worsened	3.32	<0.001	2.92	<0.001

[a] Incidence rate ratio

The patient distribution at various hospital levels differs (Gyrd-Hansen et al. 2012), and high-level hospitals generally contain patients with symptoms that are severe. Patients could also choose to visit medical centers or large hospitals if they have severe diabetes. However, the baseline DCSI score was nonsignificant in our trajectory model. This, however, may not be unreasonable because we included only newly diagnosed patients, and the variable was used to measure the site at which the patient was first diagnosed with diabetes. Thus, unless the patient suspects he or she has severe diabetes, even without being previously diagnosed by a physician, he or she is unlikely to choose medical institutions based on provider levels for the first visit according to diabetes severity.

This study has some limitations. First, as mentioned in "Methods", using "visit" as the unit of analysis ignores the distribution of visits over time. Second, our study results do not imply a causal relationship. In addition, by observing the distinct trajectories, we were unable to determine the underlying reasons for switching doctors. Although chronic disease patients might search for the most suitable physician prior to lifelong treatment, patients may change physicians because of factors such as the termination of services by that physician or the patient changing the location of residence.

Chronic disease patients, such as diabetes patients, exhibit various patterns of health-care-seeking behavior after the first diabetes diagnosis, and diverse trajectories produce various patient outcomes, with high COC producing improved patient outcomes. Factors such as the type of medical institution at which the first diabetes diagnosis was made, sex, and socioeconomic factors including income and area of residence are also critical factors associated with various COC trajectories.

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