Effects of a Population-Based Diabetes Management Program in Singapore

Woan Shin Tan, BSocSc, MSocSc; Yew Yoong Ding, MBBS, FRCP, MPH; Wu Christine Xia, BS(IT); and Bee Hoon Heng, MBBS, MSc

Diabetes is a challenging health problem worldwide. Internationally, the number of individuals with diabetes is estimated to increase from 366 million to 552 million by 2030.[1] This emerging epidemic will have increasing implications for health policy worldwide, and for our country, Singapore. Global healthcare spending on diabetes is expected to grow by 30% over the next 20 years.[2] Here, we face the same challenges of diabetes prevalence. Singapore's growing affluence, lifestyle changes, and aging population have all contributed to the prevalence of diabetes growing from 2% in 1975 to 11.3% in 2010.[3,4] Diabetes is a dynamically complex disease associated with an increased risk of microvascular and macrovascular complications. To improve health outcomes and contain costs, health systems have implemented disease management programs; they incorporate managing patients in accordance with accepted clinical guidelines, patient education, aggressive screening for complications, and early and appropriate specialty referral.[5-7] Costs can be contained by slowing the development of diabetes-related complications. While individuals value interventions from which an immediate benefit can be derived, benefits from preventive interventions that accrue into the future are often underestimated.[8] Therefore, disease management programs are often covered by third-party payers to reduce expenditures. Individual patients in fee-for-service systems such as Singapore's, however, tend to find disease management programs less attractive financially.

Studies have shown that diabetes management programs are associated with substantial improvements in processes of care.[6,9,10] However, greater compliance with processes has not been consistently linked to improvements in intermediate outcomes such as blood lipid levels.[11] Several studies reported an improvement in clinical outcomes when patients were enrolled in diabetes management programs,[6,12,13] whereas other studies found little impact.[14,15] It is also widely believed that disease management programs lower healthcare

ABSTRACT

Objectives

We evaluated the impact of Singapore's Medisave for Chronic Disease Management Program (CDMP) program for type 2 diabetes mellitus (T2DM) patients.

Study Design

A longitudinal study comparing differences in compliance with recommended diabetes care processes and management strategies, hospitalization, and costs among the Medisave for CDMP participants and propensity-matched nonparticipants.

Methods

Data on patients diagnosed with T2DM who participated in the Medisave for CDMP (n = 10,559) and eligible patients who did not participate (n = 22,089) were extracted from the National Healthcare Group (NHG) diabetes registry. Participants and nonparticipants were propensity-score matched. Processes of care, all-cause and diabetes-related hospitalization risk, and healthcare costs incurred in 2007, 2008, and 2009 were compared between groups. A difference-in-difference strategy and generalized estimating equation approach were used.

Results

Compliance with recommended processes of care improved significantly for program patients. Compared to nonparticipants, all-cause hospitalization risk for participants was significantly lower in 2007 (odds ratio [OR]: 0.76; 95% CI, 0.65-0.88) and 2008 (OR: 0.79; 95% CI, 0.68-0.92) but the difference was not statistically significant in 2009 (OR: 0.91; 95% CI, 0.79-1.05). Total healthcare cost was 14-15% lower for participants in 2007 and 2008 but not significantly different in 2009. Similar results were observed for diabetes-related hospitalization rates and inpatient costs. The policy did not have a significant impact on participants with well-controlled diabetes at baseline.

Conclusions

The extension of Medisave coverage to outpatient treatment increased the compliance with the processes of diabetes care. The policy reduced hospitalization risk and total healthcare cost in the short term but effects were not sustained by the third year.

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expenditures by reducing hospital admissions and emergency department visits. However, systematic reviews have shown that the evidence substantiating this claim remains inconclusive.[16,17]

Despite mixed results from international studies and reviews, the Singapore Ministry of Health (MOH) launched the Medisave for Chronic Disease Management Program (CDMP) in October 2006. Type 2 diabetes mellitus (T2DM) was the first condition to be covered. Prior to this, Medisave could only be used for acute inpatient and day-surgery expenses. The restiction resulted in an underutilization of outpatient services because Medisave could not be drawn upon to offset the cost to patients.

The Medisave for CDMP aims to lower financial barriers to seeking outpatient treatment with the goal of improving compliance and preventing or delaying the development of complications that could lead to hospitalization and costly inpatient treatments.[19] Although the Singapore MOH has published evaluations of the Medisave for CDMP policy,[19-21] the pre-post analysis is prone to possible regression to the mean due to the absence of a control group. In this study, using a propensity score–matching approach, we examined the longitudinal effects of extending Medisave for a population-based diabetes management program. Specifically, the aim of our study was to assess whether the participants of the Medisave for CDMP compared with nonparticipants have 1) better compliance with the recommended processes of care, 2) lower risk of all-cause and diabetes-related hospitalization, and 3) lower total all-cause annual healthcare costs and diabetes-related inpatient costs. We also investigated the heterogeneity in results across patient subgroups differentiated by the presence of diabetes-related complications and level of glycemic control at baseline.

Take-Away Points

We evaluated the effects of the Medisave for Chronic Disease Management Program (CDMP), a population-based diabetes management program, on patients diagnosed with type 2 diabetes mellitus.

- The extension of Medisave for outpatient treatment was associated with an improvement in compliance with processes of diabetes care for participating patients.
- Initial reductions in the odds of hospitalization and total healthcare cost associated with participation in the population-based diabetes management program were difficult to sustain.
- Nonetheless, cumulatively, there was a relative reduction in the overall healthcare cost for program patients over a 3-year period.

METHODS

Medisave for Chronic Disease Management Program (CDMP)

In Singapore, public healthcare is provided by 5 regional health systems: Alexandra Health (AH), Jurong Health Services (JHS), National Healthcare Group (NHG), National University Health System (NUHS), and Singapore Health Services (SHS). Together, these clusters provide 80% of all acute care service. The government primary care clinics under NHG and SHS provide approximately 20% of primary care services consumed. Each clinic provides general practitioner, nursing, allied health, and diagnostic services in a co-located facility.

Patients pay for outpatient care on a fee-for-service basis. Therefore, out-of-pocket payments associated with regular clinic visits and laboratory and screening tests can be high. Participants in the Medisave for CDMP, it was hypothesized, would face lower financial barriers and therefore be more compliant than nonparticipants with recommended strategies of diabetes management. The policy rationale was that this would in turn prevent or delay the onset of complications that would lead to hospitalization and costly inpatient treatments.

Therefore, in October 2006, individuals diagnosed with T2DM were allowed to use Medisave for outpatient care at public sector primary care clinics, public hospital specialist outpatient clinics, and private general practitioners. Previously, people were allowed to use their Medisave funds only for financing future medical needs related to, although the amount working Singaporeans contribute to these funds is substantial: 7% to 9.5% of their monthly wage, on average, for those who choose to enroll (participation in Medisave for CDMP is voluntary). Since T2DM set the precedent in October 2006, the plan has been extended to cover hypertension, hyperlipidemia, post–stroke care, asthma, chronic obstructive pulmonary disease (COPD), major depression, schizophrenia, bipolar disorder and dementia. Patients who visited the government primary care clinics for treatment of CDMP conditions incurred an annual bill of SGD 200 (USD 130) on average. SGD 300 (US $196 per account can be used per year (SGD 400 / US $261 from January 1, 2012). A SGD 30 (US $20) deductible per bill is applicable with another 15% copayment on the remaining balance (2006 exchange rate of US $1 = SGD 1.5336).

Evidence-based care components form the basis of the program. Participating clinics are all and have agreed to

accept payments through. Although payments are not linked to performance, participating clinics must agree to submit the patient outcomes to the MOH.

Each year, a participating T2DM patient should receive all of the following: 2 glycated hemoglobin (A1C) tests; 2 blood pressure (BP) measurements; 2 body weight measurements; 1 serum cholesterol level (LDL-C) test; 1 retinal assessment; 1 foot assessment; 1 nephropathy screening assessment; and (for smokers) 1 smoking habit assessment. Clinics are also provided with guidelines on when to refer patients for specialist care, as well as educational tool-kits for use by the doctors help them explain to their patients more effectively. Patients also receive booklets for recording of vital clinical indicators to aid self-monitoring. The policy assumes that when the clinics have greater accountability, the compliance rates for participants will increase over time, eventually becoming higher in comparison with nonparticipants for whom results do not have to be submitted.

Data

The study cohort includes individuals diagnosed with T2DM who had at least 1 diabetes-related consultation visit at any of the 9 NHG primary care clinics in the pre- and immediate post policy years 2006 and 2007 respectively. We have excluded individuals who are non-Singapore residents and those aged 20 years and below. To exclude potential effect of expansion of the plan within our study time frame, patients with concurrent diagnoses of COPD, asthma, schizophrenia, and major depression were excluded. The final selected patient cohort was followed from January 1, 2006, to December 31, 2009, with baseline defined as the first primary care visit made by the patient in 2007.

We used data from a diabetes registry maintained by the National Healthcare Group (NHG). Patients diagnosed with T2DM were identified in the Chronic Disease Management Data-mart (CDMD) based on the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) diagnostic codes (250.x0, 250.x2, 357.2, or 362.xx), which are available for patients who were discharged from the hospital or visited a primary care clinic. This is augmented by pharmacy medication records and laboratory records. More details on the algorithm used to identify patients with T2DM in the CDMD has been described elsewhere.[22] The registry contains data on demographic characteristics, comorbid conditions, and clinical outcomes, as well as data about healthcare resource use.

The exposure of interest is participation in Medisave for CDMP. We have defined "participants" as patients who drew on Medisave to pay for NHG primary care clinics in all 3 years (2007, 2008, and 2009). Nonparticipants comprised patients who did not use Medisave at least once throughout the study time frame of 2006 to 2009. The main outcome variables were process indicators; risk of hospitalization; and total annual healthcare cost. For processes of care, we reported the percentage of participants and nonparticipants receiving guideline-prescribed measurements of A1C, BP, LDL-C, and body weight, as well as retinal, foot and nephropathy screenings.

Hospital admissions refer to inpatient episodes at acute care hospitals managed by 3 regional health clusters (JHS, NHG, and NUHS). Total annual healthcare costs refer to the cost of resources utilized at the primary care clinics, emergency departments, specialist outpatient clinics, and inpatient wards of these regional health clusters. To define diabetes-related hospitalizations and inpatient costs, we have adopted the diabetes-related hospitalization *ICD-9-CM* codes used in Jiang et al 2005[23] (**eAppendix**, available at **www.ajmc.com**). Hospitalizations with a principal diagnosis of diabetes, cardiovascular, renal disease, lower extremity disease, eye disease, and others (mycoses, fluid, and electrolyte disorders) were considered to be diabetes-related for the study population comprising subjects diagnosed with T2DM.

Covariates include: age; gender; ethnicity (Chinese, Malay, Indian, or others); treatment regime (insulin or not); obesity; *ICD-9-CM* diagnosis of hypertension or hyperlipidemia; baseline glycemic control using A1C (<7%, 7-7.9%, ≥8%). We also constructed the 13-point Diabetes Complications Severity Index (DCSI) using *ICD-9-CM* codes of the primary and secondary diagnosis codes. It comprises 7 categories of complications and their severity levels: retinopathy, nephropathy, neuropathy, cerebrovascular, cardiovascular, peripheral vascular disease and metabolic.[24] The DSCI score (0—indicating an absence of complications—1, 2, ≥3) has been shown to a good predictor of direct healthcare costs in Singapore.[25]

Statistical Analysis

Baseline characteristics are described with mean and standard deviation for continuous variables and number and percentage for categorical variables. Differences between CDMP participants and nonparticipants were compared using absolute standardized differences.[26] A standardized difference of 0.1 or less has been suggested to denote negligible imbalance between the participant and nonparticipant groups.[27] After propensity-score matching, differences in process outcomes were com-

pared. For all-cause and diabetes-related hospitalization risk and healthcare cost, we used a combination of nonparametric propensity score matching and difference-in-differences (DiD) analysis, which some argue improves the quality of nonexperimental evaluation study results.[28]

Since participation in Medisave for CDMP was not random, we first estimated the probability of each subject selecting treatment conditional upon their baseline covariates.[29] The propensity score was determined using multivariable logistic regression using the covariates: age, gender, ethnicity, obesity, hypertension, hyperlipidemia, treatment regime, DCSI score, and glycemic control. Subsequently, pairs of treated and untreated subjects were formed using nearest neighbor matching within a caliper of 0.2 of the standard deviation of the propensity score.[29] We also imposed a common support condition in the matching algorithm to ensure that the distribution of the propensity scores of participants and nonparticipants were located in the same domain. The matching was performed using the PSMATCH2 software in Stata.[30]

We used a DiD approach to assess the effect of Medisave for CDMP on the outcomes. This method accounts for secular trends in outcomes by subtracting the change in outcomes in the nonparticipant group from the concurrent change in the participant group to derive the policy impact.[31,32] The following equation was employed:

$$y_{st} = \beta_0 + \beta_1 \text{CDMP} + \beta_2 \text{Post1} + \beta_3 \text{Post2} + \beta_4 \text{Post3} + \beta_5 (\text{CDMP} \times \text{Post1}) + \beta_6 (\text{CDMP} \times \text{Post2}) + \beta_7 (\text{CDMP} \times \text{Post3}) + \beta_8 \text{Adjustors} + \beta_{st}$$

where y_{st} is the dependent variable. CDMP is a dummy variable representing participation in the program (CDMP = 1). Three time dummies (Post1, Post2, Post3) were included to denote the years (2007, 2008, 2009) after policy implementation. The coefficient of CDMP represents the difference in the outcome of interest between participants and nonparticipants before the plan was implemented. The coefficients of the time dummies represent changes of nonparticipants in the different periods. The coefficients of the 3 interaction terms, CDMP × Post1, CDMP × Post2 and CDMP × Post3, reflect the impact of Medisave for CDMP in 2007, 2008, and 2009 respectively.

To address the correlation between repeated annual observations in outcomes across time for the same patient, we used a generalized estimating equation approach.[33] This method accounts for the correlation between observations. For the dichotomous response variables of process indicators, and hospitalization, we specified a binomial distribution with logit link. For the continuous variable of total healthcare cost, we specified a gamma distribution with log-link. In these regression models, the correlation matrix was assumed to be unstructured.

For the outcomes of all-cause hospitalization risk and total healthcare cost, we separately estimated the DiD effects for participants who at baseline, had: 1) diabetes with no complications and acceptable glycemic control (A1C <8%), 2) diabetes with no complications and poor glycemic control (A1C ≥8%), 3) diabetes with complications and acceptable glycemic control, and 4) diabetes with complications and poor glycemic control.

All analyses were conducted using Stata 11.0 (StataCorp; College Station, Texas). The National Healthcare Group Institutional Review Board approved the study protocol.

RESULTS

We identified 10,559 participants and 22,089 controls before propensity-score matching. The matched sample comprised 8881 participants and 8881 unique nonparticipants. Baseline characteristics of the unmatched and propensity-score matched samples are shown in **Table 1**. The propensity-score matched patients were well matched in 6 covariates.

Process Indicators

Post policy, sustained improvements in compliance with blood pressure measurement and weight measurement were seen in both groups of patients but participants were consistently more compliant. The policy was also associated with an improvement in compliance with A1C, lipid, and nephropathy screening tests in the participant cohort, but continued decline was observed among nonparticipants. The compliance rates for blood pressure and weight measurement improved for both groups between 2006 and 2009, but foot and retinal screening fell across the years for both cohorts during the 3-year follow-up (**Table 2**).

Utilization Outcomes

Table 3 presents the unadjusted all-cause and diabetes-related hospitalization rates and mean total healthcare cost per year. The data revealed that the unadjusted utilization and cost increased annually for the nonparticipants. For CDMP participants, the all-cause and dia-

Table 1. Baseline Profile of Patients With Type 2 Diabetes Mellitus Participating in Medisave for CDMP and Control Group

	Unmatched Participants	Unmatched Nonparticipants	Matched Participants	Matched Non-participants	Unmatched Standardized Differences	Matched Standardized Differences
Count	10,559	22,089	8,881	8,881		
Age, years, mean (SD)	60.9 (10.2)	63.5 (12.0)	61.4 (10.3)	60.9 (11.5)	0.235	0.042
Male, No. (%)	5110 (48.4)	9829 (44.5)	4192(47.2)	4311 (48.5)	0.078	0.027
Race, No. (%)						
Chinese	7632 (72.3)	16,410 (74.3)	6448 (72.6)	6354 (71.5)	0.045	0.024
Malay	1488(14.1)	2366 (10.7)	1163 (13.1)	1236 (13.9)	0.103	0.024
Indian	1166 (11.0)	2674 (12.1)	1029 (11.6)	1064 (12,0)	0.033	0.012
Others	273 (2.6)	639 (2.9)	241 (2.7)	227 (2.6)	0.019	0.010
Risk Factors, No. (%)						
Obesity	8221 (77.9)	12,190 (55.2)	6662 (74.6)	6853 (77.2)	0.495	0.061
Hypertension	9258 (87.7)	16,794 (76.0)	7614 (85.7)	7743 (87.2)	0.306	0.042
Hyperlipidemia	10,301 (97.6)	21,310 (96.5)	8645 (97.3)	8668 (97.6)	0.064	0.016
Complications, No. (%)						
DSCI: 0	7162 (67.8)	16,443 (74.4)	6220 (70.0)	6209 (69.9)	0.146	0.003
DSCI: 1	1630 (15.4)	2609 (11.8)	1269 (14.3)	1297 (14.6)	0.106	0.009
DSCI: 2	1227 (11.6)	2050 (9.3)	959 (10.8)	947 (10.7)	0.077	0.004
DSCI: ≥ 3	540 (5.1)	987 (4.5)	433 (4.9)	428 (4.8)	0.030	0.003
Glycemic Control, no. (%)						
A1C: <7	2668 (25.3)	8808 (39.9)	2504 (28.2)	2304 (25.9)	0.316	0.051
A1C: 7-7.9	4485 (42.5)	8286 (37.5)	3736 (42.1)	3803 (42.8)	0.101	0.015
A1C: ≥8	3406 (32.3)	4995 (22.6)	2641 (29.7)	2774 (31.2)	0.217	0.033
Insulin, No. (%)	1172 (11.1)	1589 (7.2)	863 (9.7)	923 (10.4)	0.136	0.022
2006 Primary Care OPP, US$, mean (SD)[a]	237.2 (149.6)	144.3 (130.0)	207.6 (118.4)	206.2 (165.5)	0.663	0.010

DSCI indicates Diabetes Severity Complications Index; A1C, glycated hemoglobin; OPP, Out-of-Pocket payment.
[a]Singapore dollar per unit of US is 1.5336 (2006).

betes-related hospitalization rates declined in the first year post policy compared with pre-policy. On average, all outcomes were better for the participants in the post policy years compared to nonparticipants.

The regression-adjusted DiD estimates are presented in Table 4. With all-cause hospitalization (Yes/No) as the outcome, the estimates of the policy effect in 2007 (OR: 0.76; 95% CI, 0.65-0.88) and 2008 (OR: 0.79; 95% CI, 0.68-0.92) were statistically significant, suggesting that we cannot reject the hypothesis that the Medisave for CDMP reduced the risk of hospitalization. However, the positive impact was not sustained in 2009 (OR: 0.91; 95% CI, 0.79-1.05). The results were similar for diabetes-related hospitalizations but the policy effect sizes were relatively larger.

For all-cause total annual healthcare costs, compared with those of nonparticipants, participants' costs were reduced significantly, by 15% (95% CI, −6% to −24%) and 14% (95% CI, −4% to −24%) in 2007 and 2008, respectively. In 2009, however, differences in cost between the 2 groups narrowed significantly (Table 4). Diabetes-related inpatient cost more than halved in 2007 and 2008 for the participant cohort. The decrease was significant and reflected the odds ratio observed for diabetes-related hospitalization for participants relative to nonparticipants. However, the policy effect was similarly not sustained in the third year.

Sub Group Analysis

Figures 1A and 1B reflect the impact of the policy on

Table 2. Percentage of Patients in the Propensity-Score Matched Sample Receiving Recommended Care by Group

	A1C Test	LDL-C Test	Nephropathy Screening	BP Test	Weight	Retinal Exam	Foot exam
2006							
Participants	95.3	87.4	87.6	13.4	8.8	50.4	66.0
Nonparticipants	94.6	88.7	88.1	12.6	8.8	52.8	69.5
P[a]	.028	.007	.358	.108	.979	.002	<.001
2007							
Participants	98.2	90.8	89.8	68.8	60.3	46.5	67.0
Nonparticipants	94.9	88.4	87.9	51.3	46.5	44.8	63.3
P[a] <0.001	<.001	<.001	<.001	<.001	.023	<.001	
2008							
Participants	98.1	90.4	89.9	67.4	59.2	45.5	67.5
Nonparticipants	89.3	84.3	84.2	57.5	52.2	41.3	60.2
P[a]	<.001	<.001	<.001	<.001	<.001	<.001	<.001
2009							
Participants	96.9	89.0	90.2	69.4	50.3	40.0	61.2
Nonparticipants	84.7	79.5	81.5	60.2	45.6	36.1	53.0
P[a]	<.001	<.001	<.001	<.001	<.001	<.001	<.001

[a]Chi-square test.

Table 3. Unadjusted Differences in Hospitalization Rate and Cost

	All-Cause Hospitalization Rate, %			All-Cause Total Healthcare Cost (US$), mean[a]		
	Participants	Nonparticipants	Difference	Participants	Nonparticipants	Difference
2006	4.2	4.1	0.1	620	648	–28
2007	3.7	5.0	–1.3	622	831	–209
2008	4.7	5.6	–0.9	744	987	–243
2009	5.6	5.9	–0.3	1007	1051	–44
	Diabetes-Related Hospitalization Rate, %			**Diabetes-Related Inpatient Healthcare Cost (US$), mean[a]**		
	Participants	**Non-Participants**	**Difference**	**Participants**	**Participants**	**Difference**
2006	1.9	1.7	0.2	75	57	19
2007	1.4	2.6	–1.2	41	132	–91
2008	1.8	2.8	–1.0	53	164	–111
2009	2.6	3.0	–0.4	152	164	–11

[a]Mean total healthcare cost have been discounted to 2006 prices using the Consumer Price Index.

all-cause hospitalization rates and total healthcare cost for patient subgroups differentiated by the presence of diabetes-related complications and level of glycemic control at baseline. The policy effects on participants with poor glycemic control at baseline were significantly positive although diminishing over the 3-year follow-up. However, the policy did not appear to benefit participants who did not have diabetes-related complications at baseline and acceptable levels of blood glucose.

DISCUSSION

Evidence-based management was thought to reduce morbidity, and therefore healthcare costs, for chronic

Table 4. Policy Effect Size for Medisave for Chronic Disease Management Program

	All-Cause Hospitalization[a]		Diabetes-Related Hospitalization[b]	
	Odds Ratio	95% CI	Odds Ratio	95% CI
Year 2007	0.76[c]	0.65-0.88	0.46[c]	0.34-0.63
Year 2008	0.79[d]	0.68-0.92	0.54[c]	0.40-0.73
Year 2009	0.91	0.79-1.05	0.76	0.57-1.01
	All-Cause Total Healthcare Cost		Diabetes-related Inpatient Cost	
	Incident Cost Ratio	95% CI	Incident Cost Ratio	95% CI
Year 2007	–0.15[c]	–0.24 to –0.06	–1.06[d]	–1.73 to –0.39
Year 2008	–0.14[d]	–0.24 to –0.04	–1.28[c]	–1.88 to –0.69
Year 2009	0.03	–0.08 to 0.15	–0.55	–1.13 to 0.03

Adjusted for: age, sex, ethnic group, hypertension, hyperlipidemia, obesity, Diabetes Complications Severity Index, glycemic control status, insulin therapy, and time trend.
[a]Generalized Estimating Equation with the logit link function, binomial distribution, and unstructured covariance structure; odds ratio greater than 1 indicates higher odds of hospitalization.
[b]Generalized Estimating Equation with the log link function, gamma distribution and unstructured covariance structure; positive coefficient indicates higher cost and negative coefficient indicates lower cost.
[c]$P < .001$; [d]$P < .01$.

diseases. Globally, governments are pursuing payment reforms to align economic and health incentives to shift the focus towards preventive and outpatient-oriented care. Singapore is no exception. The extension of Medisave to population-based disease management programs represents an important shift from an episodic model of care toward overall patient management.

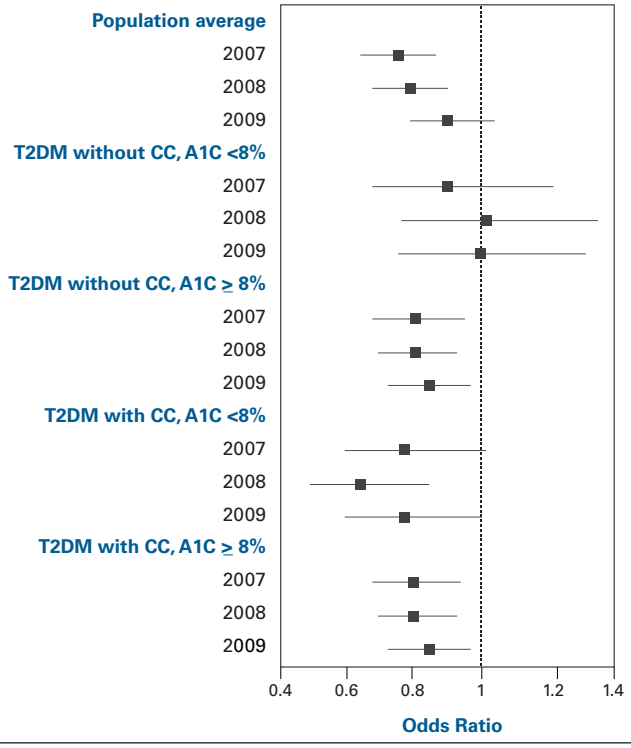
Our study included a large cohort of primary care diabetes patients using a unique diabetes registry database in Singapore. Compared to matched control patients, program participants were more compliant with processes of diabetes care and had lower odds of hospitalization in the first 2 years of follow-up. Total healthcare costs were similarly reduced but the positive effects were not maintained in the third year.

Higher cost sharing creates financial barriers that discourage patients from using recommended services.[34] The Medisave for CDMP policy effectively lowers the relative prices of outpatient treatment to encourage regular monitoring of clinical outcomes within the context of a disease management program. Studies that have evaluated the influence of copayment reductions on medications have noted positive impact on medication adherence.[35,36] Medisave for CDMP, too, reduces the out-of-pocket costs to patients. That, combined with the monitoring of outcomes by the Ministry of Health, appear to have motivated both patients and providers to better meet the standards of care based on the set of process indicators monitored by MOH. Similar to other studies,[5,10,37,38,39] our results showed a significant improvement in the participant group in meeting the required examination frequencies for A1C, blood pressure, and blood cholesterol measurements, and foot and nephropathy screening. Higher rates of compliance with A1C, blood cholesterol and nephropathy screening were achieved because the required laboratory tests are grouped as an annual T2DM monitoring panel in the NHG primary care clinics.

Comparatively, the rates for nonlaboratory assessments, such as weight and blood pressure measurement, and retinal and foot screening, were lower, although we observed significant improvements in blood pressure and weight measurements because these activities have become part of the routine care to be carried out before the patient consults the physician. One reason the rates of diabetic retinal photography screening and foot examination may have dropped at the primary care clinics is because more patients previously screened positive and were referred for specialist care. However, for retinal screening, which registered the lowest compliance rates, previous studies have suggested that receiving diabetes education is associated with an increased screening rate for diabetic retinopathy.[40,41] Our results suggest that patient education regarding eye care might be inadequate in this population and can be strengthened.

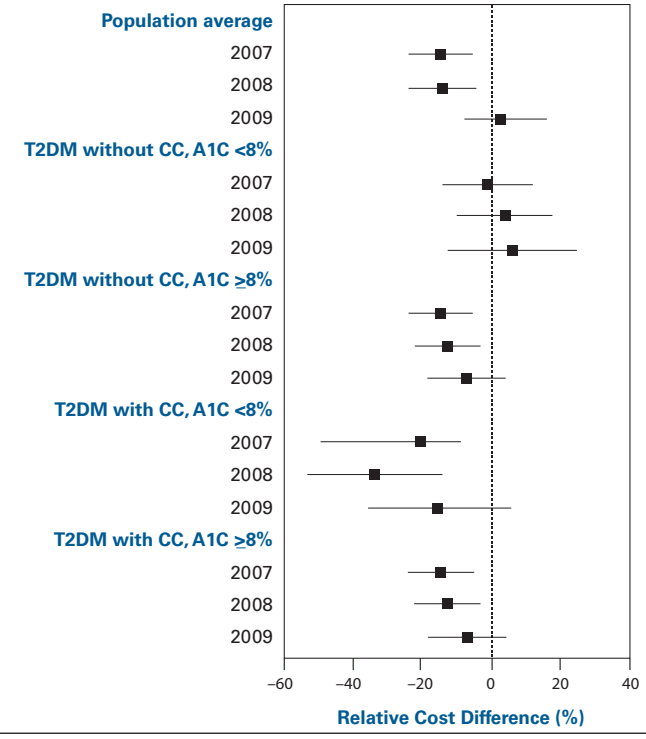
Overall, we found that patients in the diabetes management program experienced lower odds of all-cause as

Figure 1A. Participants Odds of All-Cause Hospitalization Compared With Nonparticipants[a]



CC indicates complications; T2DM, Type 2 diabetes mellitus.
[a]Analyses were carried out for the following numbers of participants and non-participants: T2DM without CC, A1C < 8% (4320 vs 4274); T2DM without CC, A1C ≥ 8% (1900 vs 1935); T2DM with CC, A1C <8% (1920 vs 1833); and T2DM with CC, A1C ≥ 8% (741 versus 839).

Figure 1B. Difference in Annual All-Cause Total Healthcare Cost Between Participants and Non-Participants[a]



CC indicates complications; DM, Type 2 diabetes mellitus.
[a]Generalized Estimating Equation with the log link function, gamma distribution and unstructured covariance structure. The following variables, were adjusted for in the model: age, sex, race, hypertension, hyperlipidemia, insulin use, and time trend.

well as diabetes-related hospitalization and healthcare costs in the first 2 years, but the effects were not sustained in the third year. This supports the findings of systematic reviews that positive effects of disease management programs tend to diminish with longer lengths of follow-up.[42,43] Firstly, in the initial phases of the program, better professional care could have contributed to the improvements in outcomes but regression to previous clinical practices[44,45] could narrow the reductions at 3 years. Secondly, long-standing behavioral change in particpating patients[45] necessary for improving self-management metabolic control may not have occurred. The program could have delayed the onset of symptoms requiring hospitalizations in the short-term rather than eliminate complications and their associated healthcare utilization and cost.[46] Thirdly, the routine care for control patients could also have improved over time due to practice improvements across the board and thereby narrowing the differences in outcomes. [44,47]

We found that the policy effects varied across patient subgroups. While we observed positive and significant reductions in hospitalization risk and costs for patients with poor glycemic control, patients who had no complications and well-controlled blood glucose levels at baseline did not appear to have benefited significantly from the policy. Overall, the average policy effect was attenuated by patients with well-controlled diabetes at baseline. Our results support the evidence in literature that diabetes patients with poorly controlled diabetes at baseline benefit more from frequent measurement of glycemic levels, cholesterol levels, and systolic blood pressure levels. [13,39] Outcomes could have improved due to adjustments made, because of regular monitoring, to the treatment of patients with uncontrolled risk factors.

However, as a compliance-oriented program, the Medisave for CDMP may have limited impact on patients with well-controlled diabetes in the 3-year follow-up. Future evaluations could incorporate a longer-term tracking of the health outcomes of this group. Greater focus can be placed on strengthening the self-management capabilities of these patients to prevent the development of complications in the longer term.

Limitations

This research is limited in several scopes. First, because the program was implemented nationwide, we were unable to conduct a randomized trial. Due to nonrandomization, patients who participated in Medisave for CDMP may differ from nonparticipants systematically. Although we have tried to adjust for selection bias using propensity score matching and DiD, we cannot fully exclude the possibility that unmeasured differences between case and control might influence our results.

Secondly, due to the noncaptive healthcare system in Singapore, patients are able to choose providers on an episodic basis. To minimize this bias, we have included only patients who are consistent users of NHG primary care services using the criteria of at least 1 diabetes-related consultation visit at a NHG primary care clinic for T2DM in 2006 and 2007. As national-level data on healthcare resource use is not publicly available, we were only able to measure use and costs incurred in the 3 regional health clusters (JHS, NHG and NUHS). However, consultations and admissions outside of these clusters are not expected to differ systematically between the program and comparator groups.

Lastly, the NHG primary care clinics are one-stop centers providing medical, nursing, allied health, laboratory, and radiology services in a co-located facility. Our results may not apply to program patients seen by solo general practitioners. Nevertheless, our results should be broadly representative since government primary care clinics account for 77% of all Medisave for CDMP attendances.[21]

CONCLUSION

The change in policy is a necessary step towards addressing the misalignment in health and economic incentives between acute and outpatient settings. Compliance with the processes of diabetes care improved among participants in a primary care setting. Overall, the policy reduced hospitalization risk and total healthcare cost in the short term, but effects were not sustained by the third year. Our results also suggest that the policy had varying impacts on different patient subgroups. The likelihood of hospitalization and healthcare cost of participants who had well-controlled diabetes were not reduced.

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Author Affiliations: From Health Services and Outcomes Research Department, National Healthcare Group, Singapore (WST, YYD, BHH); Department of Geriatric Medicine, Tan Tock Seng Hospital, Singapore (YYD); and Medical Affairs, Alexandra Hospital, Singapore (WCX).

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Address correspondence to: Woan Shin TAN, Health Services and Outcomes Research Department, National Healthcare Group, 6 Commonwealth Lane, #04-01/02 GMTI Building, Singapore 149547. E-mail: woan_shin_tan@nhg.com.sg.

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