Lowering Cost Share May Improve Rates of Home Glucose Monitoring Among Patients with Diabetes Using Insulin

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ABSTRACT

BACKGROUND: Not much is known about the extent to which lower cost share for blood glucose strips is associated with persistent filling.

OBJECTIVE: To evaluate the relationship between cost sharing for blood glucose testing strips and continued use of testing strips.

METHODS: This is a retrospective observational study using medical and pharmacy claims data integrated with laboratory hemoglobin A1c (A1c) values for patients using insulin and blood glucose testing strips. Diabetic patients using insulin who had at least 1 fill of blood glucose testing strips between 2010 and 2012 were included. Patients were divided into a low cost-share group (out-of-pocket cost percentage of total testing strip costs over a 1-year period from the initial fill < 20%; n = 3,575) and a high cost-share group (out-of-pocket cost percentage ≥ 20%; n = 3,580). We compared the likelihood of continued testing strip fills after the initial fill between the 2 groups by using modified Poisson regression models.

RESULTS: Patients with low cost share had higher rates of continued testing strip fills compared with those with high cost share (89% vs. 82%, $P < 0.001$). Lower cost share was associated with greater probability of continued fills (adjusted risk ratio [aRR] = 1.05, 95% CI = 1.03-1.07, $P < 0.001$). Other patient characteristics associated with continued fills included type 1 diabetes diagnosis, types of insulin regimens, and health insurance plan type. In a subset analysis of patients whose A1c values at baseline were above the target level (8%) set by the National Committee for Quality Assurance guidelines, we saw a slight increase in magnitude of relationship between cost share and continued fills (RR = 1.06, 95% CI = 1.03-1.10, $P < 0.01$).

CONCLUSIONS: There was a statistically significant association between cost share for testing strips and continued blood glucose self-monitoring. Among patients not achieving A1c control at baseline, there was an increase in the magnitude of relationship. Lowering cost share for testing strips can remove a barrier to persistence in diabetes self-management.

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What is already known about this subject

- Financial burden has been identified as an important barrier to diabetes self-management practices, particularly the frequency of glucose self-monitoring.
- Regular self-monitoring of glucose is more justified in diabetes patients using insulin due to evidence of improved hemoglobin A1c levels than in patients not using insulin.
- Diabetic patients who do not meet A1c control targets are in greater need for more frequent self-monitoring of blood glucose.

What this study adds

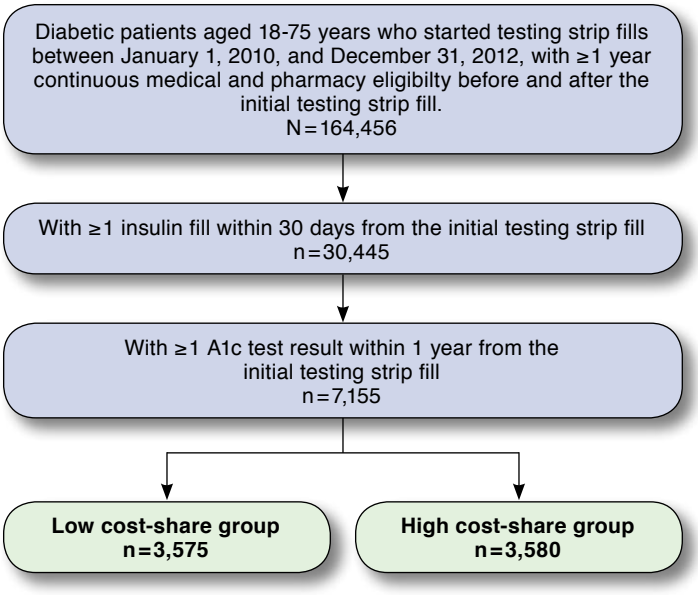
- This study quantified the relationship between cost sharing for blood glucose testing strips and continued dispensing of testing strips, particularly in the context of the level of glycemic control.
- Study findings suggested that cost sharing that falls below 20% of testing strip costs can facilitate persistent self-monitoring, especially among those not achieving glycemic control.
- Payers and employers may consider including diabetes testing strips in lower cost-share tiers or informing members about preferred testing strips that are in the lower cost-share tiers.

Self-monitoring of blood glucose (SMBG) is a key component of the care regimen for people with insulin-dependent diabetes.[1-3] Guidelines from the American Diabetes Association (ADA), as well as from the American Association of Clinical Endocrinologists and the American College of Endocrinology, recommend SMBG at least 3 times daily for patients on high intensity insulin regimens and more often for those who do not meet glycemic goals.[4-8] In practice, however, as many as 23% of people with insulin-dependent diabetes do not regularly monitor glucose levels.[9]

Literature dealing with possible reasons for the reduction or discontinuation of self-monitoring is sparse. In 1 study, patient perceptions of health professionals' attitudes seemed to affect self-monitoring, since it was found that some patients stopped self-monitoring because of their perceived disinterest on the part of health professionals in the meter readings provided by patients.[10] Another study identified other reasons for SMBG reduction or discontinuation that included getting stable and predictable readings and increased awareness of bodily signs by participants.[10] Conversely, reassurance and habit were found to be key reasons for the continuing of self-monitoring.[10]

Financial burden has also been identified as an important barrier to regular SMBG practices. In the United States, a large Kaiser Permanente study found that, among pharmacologically treated patients with type 1 or type 2 diabetes (with or without insulin use), the proportion of patients with daily SMBG and proportion of patients with ≥ 3 times SMBG daily were lower in patients with higher out-of-pocket expenditures for glucometer strips than in patients with lower out-of-pocket costs, especially among those who were economically disadvantaged.[11] As expected, a separate study among individuals

FIGURE 1 Sample Attrition



A1c = hemoglobin A1c.

with insulin-dependent diabetes found that those with lower household incomes spent a larger proportion of their income on medical supplies than those with higher incomes and so may have been less likely to monitor blood glucose levels.[12] Out-of-pocket costs were also related to stopping or irregular self-monitoring among patients with diabetes in several international studies.[13-16]

The price of blood glucose testing strips ranges from around 20 cents per strip to as high as 2 dollars per strip, and insurance coverage and payment level vary according to benefit plan.[17] For diabetic patients who are recommended to perform self-monitoring frequently (e.g., once per day or more), the total costs for 1 year can be high. Out-of-pocket cost for testing strips, as an added financial burden for diabetic patients who are typically on multiple medications, has been shown to be an important contributor to missed opportunities for the continued, regular use of testing strips.[11-14] While intuitive, this is not universally accepted as a clear pathway for better diabetes management. For example, a large cross-sectional Canadian study reported that implementing quantity limits for reimbursement of blood glucose testing strips (i.e., limits of a maximum of 3,000 reimbursed strips for patients using insulin, 400 strips for patients on oral antidiabetic drugs at increased risk for hypoglycemia, and 200 strips for all other diabetic patients) was not related to worsening short-term clinical outcomes.[18] This study, however, was limited because it did not examine the direct effect of this quantity-limit policy on patient self-monitoring practices.[18]

Our study was designed to evaluate the relationship between cost sharing and persistence with blood glucose testing strip fills among diabetic patients using insulin who had at least 1 testing strip fill. We limited the study population to those with insulin use because it has been suggested that SMBG is more justified in type 1 and type 2 diabetes patients using insulin for its beneficial effect on hemoglobin A1c (A1c) than in patients not using insulin.[19] Furthermore, given the recommendation of more frequent self-monitoring for patients who do not meet glycemic goals,[8,20] the relationship between cost share and continued testing strip fills was examined in a subset of patients not achieving glycemic control (i.e., A1c more than 8.0% as set by the National Committee for Quality Assurance guidelines) before initiating glucose monitoring using testing strips. Our primary hypothesis was that lower cost share was related to a higher likelihood of continued testing strip fills after the initial fill. The secondary hypothesis was that patients not meeting glycemic control targets will benefit more from lower cost share in terms of persistence with testing strip fills, since their need for SMBG is higher.

Methods

Data Source

Data were compiled from administrative medical and pharmacy claims obtained from the HealthCore Integrated Research Environment (HIRE). HIRE contains claims data for approximately 25 million Blue Cross Blue Shield health plan members across the United States. Researchers had access to a limited dataset with no patient identifiers. All study data were kept anonymous in full compliance with relevant provisions of the Health Insurance Portability and Accountability Act. Area median household income data were obtained by linking to the Area Health Resource File 2012-2013 based on ZIP codes of the areas in which the patients resided.[21]

This nonexperimental study, which was conducted under the research exception provisions of the Privacy Rule 45 CFR 164.514(e), was exempt from investigational review board review.

Study Design and Population

This retrospective observational study included commercially insured diabetic members aged 18-75 years who were new testing strip users and were using insulin.

Diabetes was defined as having ≥1 medical claim with *International Classification of Diseases, Ninth Revision, Clinical Modification* diabetes diagnosis codes during the study period (see Appendix, available in online article).[3] All patients had a blood glucose testing strip fill between January 1, 2010, and December 31, 2012, with no testing strip fills during the previous year, and all had continuous health plan enrollment for 1 year before and after the index date (i.e., the earliest blood glucose testing strip fill date during the study period). Patients were excluded if they had serious chronic conditions (coronary

artery bypass surgery or percutaneous coronary intervention, ischemic vascular disease, thoracic aortic aneurysm, chronic heart failure, previous myocardial infarction, chronic renal failure, dementia, blindness, and amputation) according to the definitions from Healthcare Effectiveness Data and Information Set criteria. A total of 164,456 patients met this initial criteria.[22]

Among those patients meeting the previously mentioned criteria, insulin users were identified if they had at least 1 pharmacy claim for an insulin medication fill using Generic Product Identifier codes within 1 month from the index date (n = 30,445; see Appendix).[3] Patients were also required to have at least 1 A1c testing result to assess the level of glycemic control in the year after the initial testing strip fill. A total of 7,155 patients met this criteria and comprised the final study sample (Figure 1).

For the second study hypothesis, we examined the relationship between cost share and subsequent testing strip fills in a subset of patients who did not meet the glycemic control goal in the year before the initial testing strip fill (n = 2,969).

Study Group Assignment

Patient cost share for blood glucose testing strips was calculated as the out-of-pocket cost percentage of total testing strip costs, created by dividing out-of-pocket costs by total testing strip costs and multiplying by 100%. Out-of-pocket cost was the sum of copays, coinsurances, and deductibles paid by a patient over the 1-year period from the first testing strip fill. Total testing strip cost was the sum of out-of-pocket and health plan-paid amounts over the same period of time. We chose to use cost share percentages rather than dollar amounts because dollar amounts would be affected by adherence differences in addition to benefit design differences, since people with more testing fills (better adherence) are likely to pay more out-of-pocket than those with fewer fills (lower adherence).

Using the median cost share percentage (20%) in our final sample, the study population was divided into 2 study groups: the low cost-share group (out-of-pocket cost percentage less than 20%) and the high cost-share group (out-of-pocket cost percentage at or above 20%). The study population was roughly split between these 2 groups (50% low cost share and 50% high cost share).

Statistical Analysis

Descriptive statistics including means (± standard deviation [SD]) and frequencies were reported for continuous and categorical data, respectively. Differences in descriptive characteristics between the low versus high cost-share groups were assessed with t-tests for numeric data and Pearson's chi-square tests for categorical data.

The outcome of interest was continued use of blood glucose testing strips, defined as "at least 1 subsequent fill after the initial fill." The likelihood of patients with continued use in the low cost-share group was compared with that in the high cost-share group through relative risk (RR), which was estimated from the modified Poisson model with the associated standard errors obtained from the Sandwich method,[23,24] taking into account age, gender, health insurance plan type (health maintenance organization [HMO]/preferred provider organization [PPO]/consumer-driven health plan [CDHP]), area median household income, type 1 diabetes status, types of insulin regimen, baseline oral antidiabetic (OAD) dispensing, baseline diabetic adverse events (hypoglycemia/ketoacidosis), Deyo-Charlson Comorbidity Index (DCI), baseline medications for metabolic disorder, cost share for all prescription claims, and cost share for all medical claims.

The association between cost share and continued use of testing strips was then examined in the subset of patients not meeting glycemic control, in order to evaluate the association in the context of patient glycemic levels.

All statistical analyses were conducted with SAS 9.4 software for Windows (SAS Institute, Cary, NC). Alpha was set at 0.05.

Results

Patient Characteristics

The analysis comprised 7,155 patients (3,575 in the low cost-share group and 3,580 in the high-cost share group; Table 1). Patient demographic and clinical characteristics were compared between the 2 groups to examine any differences in baseline profile. Compared with the low cost-share group, those in the high cost-share group were slightly older (low cost share: 49 years; high cost share: 50 years; $P < 0.01$) and had a lower area median household income (low cost share: $56,686; high cost share: $52,872; $P < 0.001$). The most common comorbid conditions in both groups were dyslipidemia (low cost share: 58.8%; high cost share: 60.3%; $P = 0.22$) and hypertension (low cost share: 57.2%; high cost share: 60.3%; $P = 0.01$). Proportions of patients with baseline fills of medications for metabolic disorders (i.e., cardiovascular disease, dyslipidemia, or hypertension) and OAD medications were higher in the high cost-share group than in the low cost-share group (medications for metabolic disorders: 74.9% high vs. 72.1% low cost share, $P < 0.05$; OADs: 57.4% high vs. 48.6% low cost share, $P < 0.001$). The DCI score and proportion of patients on a basal-only regimen were lower among patients with high cost share than among those with low cost share (1.8 vs. 2.0, $P < 0.001$, and 34.6% vs. 22.5%, $P < 0.001$, respectively; Table 1).

The median out-of-pocket cost share of total testing strips in the 1-year follow-up period was 9% and 29% in the low cost-share and high cost-share groups, respectively. Mean out-of-pocket costs were $89 and $225 in the low and high cost-share groups, respectively ($P < 0.001$). As expected, total prescription cost share and medical cost share during the 1-year follow-up were lower in the low cost-share group (mean 20% prescription, 21% medical) than in the high cost-share group (mean

TABLE 1 Baseline Demographic and Clinical Characteristics of Diabetic Patients on Insulin Using Blood Glucose Testing Strips

	Users of Insulin		
	Low Cost Share (n = 3,575)	High Cost Share (n = 3,580)	*P* Value[a]
Demographic characteristics			
Age (on index date), mean (SD)	49 (12.7)	50 (11.2)	< 0.010
Age category, n (%)			< 0.001
18-44	1,172 (32.8)	986 (27.5)	
45-64	2,098 (58.7)	2,408 (67.3)	
65-75	305 (8.5)	186 (5.2)	
Gender, n (%)			0.490
Female	1,675 (46.9)	1,648 (46.0)	
Male	1,900 (53.1)	1,932 (54.0)	
Plan type, n (%)			< 0.001
HMO	1,275 (35.7)	1,433 (40.0)	
PPO	2,129 (59.6)	1,853 (51.8)	
CDHP	171 (4.8)	294 (8.2)	
Area median household income, $, mean (SD)	56,686 (14,351.99)	52,872 (13,929.44)	< 0.001
Area median household income category, n (%)			< 0.001
$0-$39,999	351 (9.8)	549 (15.3)	
$40,000-$59,999	1,801 (50.4)	1,857 (51.9)	
$60,000-$79,999	990 (27.7)	833 (23.3)	
≥ $80,000	207 (5.8)	163 (4.6)	
Unknown	226 (6.3)	178 (5.0)	
Clinical characteristics			
DCI	2.0 (1.6)	1.8 (1.4)	< 0.001
Type 1 diabetes diagnosis, n (%)	352 (9.8)	251 (7.0)	< 0.001
Type of insulin regimen, n (%)			< 0.001
Basal only	806 (22.5)	1,239 (34.6)	
Bolus use only	671 (18.8)	317 (8.9)	
Premixed use only	149 (4.2)	208 (5.8)	
Basal and bolus use only	1,773 (49.6)	1,540 (43.0)	
Other insulin/combination	176 (4.9)	276 (7.7)	
Comorbid conditions, n (%)			
Dyslipidemia	2,103 (58.8)	2,157 (60.3)	0.220
Hypertension	2,045 (57.2)	2,158 (60.3)	0.010
Renal disease	202 (5.7)	146 (4.1)	< 0.001
Fill for metabolic disorder medication,[b] n (%)	2,579 (72.1)	2,682 (74.9)	0.010
Fill for OAD medications, n (%)	1,737 (48.6)	2,055 (57.4)	< 0.001
Diabetic adverse events, n (%)	323 (9.0)	293 (8.2)	0.200
Cost of total testing strips,[c] $			
Out-of-pocket amounts, $, mean (SD)	89 (114.69)	225 (250.84)	< 0.001
Median, %	43	156	
Health plan-paid amounts, $, mean (SD)	1,058 (890.17)	439 (448.41)	< 0.001
Median, %	817	292	
Out-of-pocket cost-share percentage, mean (SD)	8 (6.89)	37 (19.02)	< 0.001
Median, %	9	29	
Cost-share percentage for all pharmacy claims[d] (n = 7,026)			
Mean (SD)	20.14 (16.32)	31.61 (20.63)	< 0.001
Median, %	16.22	25.56	
Cost-share percentage for all medical claims[d] (n=7,072)			
Mean (SD)	21.31 (18.6)	29.45 (22.03)	< 0.001
Median, %	16.29	23.68	

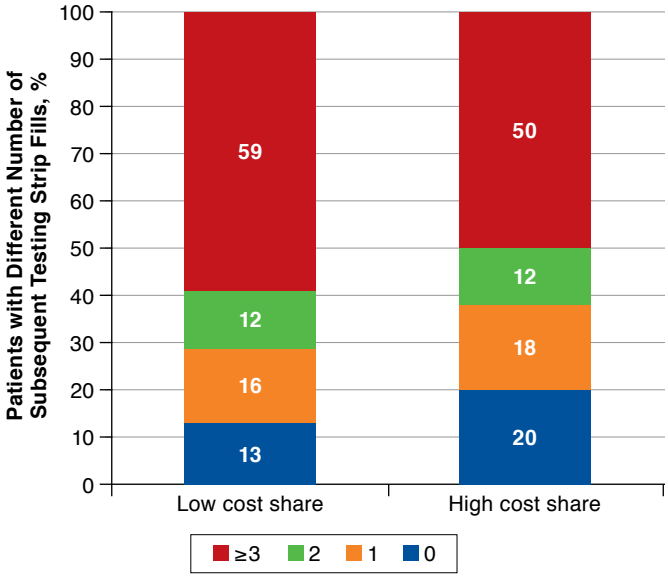
[a] *P values were derived from chi-square tests for categorical variables and t-tests for continuous variables.*
[b] *One or more medications for treatment of cardiovascular disease, dyslipidemia, or hypertension.*
[c] *In 1-year period following initial testing strip fill.*
[d] *Variable had missing values when division by zero occurred (i.e., when products were provided with no plan and patient-paid amounts).*
CDHP = consumer-driven health plan; DCI = Deyo-Charlson Comorbidity Index; HMO = health maintenance organization; OAD = oral antidiabetic; PPO = preferred provider organization; SD = standard deviation.

TABLE 2 Descriptive Statistics for Subsequent Blood Glucose Testing Strip Use Among Patients with Diabetes on Insulin During 12 Months After Initiating Testing Strip Fill

	Users of Insulin				
	Low-Cost Share (n = 3,575)		High-Cost Share (n = 3,580)		*P* Value[a]
Subsequent testing strip fills, n (%)					< 0.001
0 fill	389	(10.9)	635	(17.7)	
1 fills	461	(12.9)	541	(15.1)	
2 fills	395	(11.0)	430	(12.0)	
≥ 3 fills	2,330	(65.2)	1,974	(55.1)	
Average number of subsequent testing strip fills, mean (SD)					
Among all patients	4.7	(3.8)	4.0	(3.8)	< 0.001
Among patients with ≥ 1 subsequent fill	5.3	(3.6)	4.8	(3.6)	< 0.001
Number of days of supply per fill, mean (SD)	29.2	(34.1)	25.2	(23.9)	< 0.001
Median	20.5		20.0		

[a]*P values were derived from chi-square tests for categorical variables and t-tests for continuous variables.*
SD = standard deviation.

FIGURE 2 Distribution of Patients with Different Number of Subsequent Testing Strip Fills Among Those Not Meeting Glycemic Control at Baseline (n = 2,969)



32% prescription, 29% medical, both with $P < 0.001$, compared with the low cost-share group; Table 1).

Glucose Test Strip Use

Overall, 86% patients had at least 1 subsequent testing strip fill after the initial fill, including 14% with 1 subsequent fill, 12% with 2 subsequent fills, and 60% with 3 or more subsequent fills.

The proportion of patients who continued the use of testing strips was higher in the low cost-share group (89%) than in the high cost-share group (82%; $P < 0.001$). Among those with at least 1 subsequent testing strip fill, the mean number of subsequent fills was greater in the low cost-share group than in the high cost-share group (5.3 vs. 4.8, respectively, $P < 0.001$; Table 2).

In the subset of patients who did not achieve glycemic control goal at baseline, there is a similar pattern of more subsequent fills in the lower cost-share group (Figure 2).

Multivariable Analysis

After controlling for key factors, patients with low cost-share for testing strips were more likely to continue testing strip fills after the initial fill, compared with the high cost-share group (RR = 1.05; 95% confidence interval [CI] = 1.03-1.07; $P < 0.001$; Table 3). Patients with type 1 diabetes were more likely to continue testing strip fills than those without (RR = 1.03, 95% CI = 1.00-1.06, $P = 0.02$). Patients on a bolus only regimen or a basal and bolus only regimen were more likely to continue fills than those on basal only (RR = 1.15, 95% CI = 1.11-1.19 and RR = 1.15, 95% CI = 1.12-1.19, $P < 0.001$, respectively). Patients in PPO or CDHP plans were also more likely to continue fills than those with HMO plans (RR = 1.03, 95% CI = 1.01-1.06 and RR = 1.08, 95% CI = 1.04-1.12, $P < 0.01$, respectively).

Among patients who did not meet glycemic control goal before the initial testing strip fill, we observed that lower cost sharing was related to a higher likelihood of continued fills (RR = 1.06, 95% CI = 1.03-1.10, $P < 0.01$).

Discussion

This real-world observational study demonstrated that among our patient population, the cohort with lower cost share for blood glucose testing strips was more likely to continue use of testing strips and also had more total fills than patients who had higher cost share. We chose to use a dichotomous median cost-share grouping, since this allows for balanced comparison groups of nearly equal sample sizes, and the measure of association of RR from the comparison of 2 groups is easy to interpret. Meanwhile, we conducted a sensitivity analysis by categorizing the study sample into 4 groups using quartiles of cost-share percentage and found that the proportions of patients having subsequent fills were 89%, 89%, 83%, and 81% in the 4 groups of lowest to highest cost share, respectively. This is consistent with our conclusion that lower cost share was related to higher likelihood of the continued dispensing of testing strips.

TABLE 3 Modified Poisson Regression Modeling Probability of Having Subsequent Testing Strip Fills

	Diabetic Insulin Users (N = 7,155)		
	aRR	95% CI	*P* Value
Low cost share vs. high cost share	1.05	1.03-1.07	< 0.0001
Aged 45-64 years vs. 18-44 years	1.02	1.00-1.05	0.0700
Aged 65-75 years vs. 18-44 years	1.04	1.00-1.09	
Female vs. male	1.01	0.99-1.03	0.4300
Income: $40,000-$60,000 vs. $0-$40,000	1.02	0.98-1.05	0.5100
Income: $60,000-$80,000 vs. $0-$40,000	1.00	0.97-1.04	
Income: ≥$80,000 vs. $0-$40,000	0.99	0.94-1.04	
Type 1 diabetes diagnosis: yes vs. no	1.03	1.00-1.06	0.0200
Baseline OAD medications: yes vs. no	0.98	0.96-1.00	0.0400
Baseline diabetic adverse events: yes vs. no	1.01	0.98-1.05	0.4100
Baseline chronic condition medications: yes vs. no	1.00	0.98-1.03	0.7200
Baseline cost share for all pharmacy claims (continuous)	1.00	1.00-1.00	0.7800
Baseline cost share for all medical claims (continuous)	1.00	1.00-1.00	0.8800
Types of insulin regimen (reference: basal only)			< 0.0001
Bolus only	1.15	1.11-1.19	
Premixed only	1.05	0.99-1.11	
Basal and bolus only	1.15	1.12-1.19	
Other	1.03	0.97-1.09	
Plan type: PPO vs. HMO	1.03	1.01-1.06	< 0.0100
Plan type: CDHP vs. HMO	1.08	1.04-1.12	
DCI (continuous)	1.01	1.00-1.01	0.1200

aRR = adjusted risk ratio; CDHP = consumer-driven health plan; CI = confidence interval; HMP = health maintenance organization; OAD = oral antidiabetic; PPO = preferred provider organization.

Most existing literature on discontinuation of self-monitoring through use of testing strips included patients who were not using insulin, had relatively small sample sizes, and were from countries other than the United States.[10,13,25] Our study was conducted among a large population of diabetic patients in the United States who were using insulin. Previous studies of the effect of financial burden on diabetes management largely focused on the frequency of self-monitoring (and showed a negative effect of financial burden on self-monitoring),[11,12,14] while our study focused on the *continued* dispensing of testing strips after the initial fill. Given the paucity of studies on patient persistence in blood glucose self-monitoring, our findings contributed new evidence that financial burden is a barrier to SMBG practices.

A strength of this study is that the association of cost share and self-monitoring was examined in a subset of patients who did not meet glycemic control before the initial testing strip fill. We found that the association in this subset of patients was slightly stronger than that among the entire cohort. This finding has clinical importance, since patients not meeting glycemic target levels are encouraged to perform self-testing more frequently.[7,8] In this study population, we also found that continued use of testing strips were related to a higher likelihood of glycemic control.[26] Accordingly, these patients may benefit to a larger extent from any actions or programs that promote continued testing strip use.

An encouraging finding from our study was that those in greater need of consistent glucose monitoring (i.e., with a type 1 diabetes diagnosis, or on bolus only or basal and bolus only regimens vs. basal only) were more likely to have continued use of testing strips. This is consistent with the ADA's recommendation that SMBG be performed more frequently in patients on highly intensive insulin regimens that includes multiple insulin injections.[7]

Our study found that lower cost share was related to a higher likelihood of continued blood glucose self-monitoring and that the association remained statistically significant after adjusting for relevant patient characteristics. The findings suggested that cost sharing that falls below 20% of testing strip costs can facilitate persistent self-monitoring, particularly among those not achieving glycemic control. Based on this finding, payers and employer groups may consider including diabetes testing strips in lower cost-share tiers (e.g., coverage by Medicare Part B of glucose testing strips as durable medical equipment and Anthem's benefit designs that include coverage for glucose testing strips) or communicating to members the preferred testing strips that are in the lower cost-share tiers. One way to make sure patients get the right testing strips is for providers to ensure that the glucose meters prescribed to

patients are compatible with the testing strips covered under the lowest tier formulary of patient health plans. Patients may also be encouraged to seek out glucose monitoring kits that use the lower cost testing strips.

Limitations

This study has several limitations to be considered. First, pharmacy fills do not necessarily confirm actual use of dispensed testing strips, so the relationship between cost share and actual continued testing may be overestimated. In addition, there can be different days of supply related to each fill, and in this study, no threshold in number of days was used to define a fill to be included. We found that, on average, each fill was for around 29 and 25 days of supply in low and high cost-share groups, respectively.

Second, the patients included in this study were from a single large commercial insurer, which may not be representative of all insulin-using patients who use blood glucose testing strips. A population of commercially insured individuals also results in a cohort that is younger and healthier than the overall population with diabetes. Although findings regarding an association between age and frequency of SMBG have been inconsistent, the presence of fewer comorbidities has been related to reduced SMBG.[11,14,27] Finally, patients may have obtained blood glucose testing strips through sources other than their health plans (e.g., from over-the-counter purchases). The fact that this sample had at least 1 first fill partly helps to alleviate this concern.

Conclusions

Diabetic patients using insulin were more likely to continue use of testing strips when they had a lower level of cost sharing. Lowering cost sharing for testing strips can remove a barrier to persistence of diabetes self-management.

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DISCLOSURES

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Study concept and design were contributed by all the authors. Xie took the lead in data collection, along with Agiro, and data interpretation was performed by all the authors. The manuscript was written by Xie and Agiro, along with DeVries, and revised by Xie, Agiro, and Devries, along with Bowman.

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APPENDIX Codes for Diabetes Diagnosis, Insulin, Comorbidity, and Metabolic Disorder Medications

Description	ICD-9-CM Diagnosis Codes	GPI Codes	HCPCS
Diabetes diagnosis	250.xx, 357.2x, 362.0x, 366.41, 648.0x		
Oral antidiabetic drug medication		2750x, 2715x, 2799x, 2710x, 2728x, 2717, 2755x, 2720x, 2760x	
Diabetic testing strips		94100030006100, 94100030009800, 94100030006000	
Type 1 diabetes diagnosis	250.x1, 250.x3, V53.91	2710x	E0784, J1817
Insulins			
Basal		27104003x, 27104006x, 27101020x, 27101040x, 27102040x, 27103020x, 27103040x, 27104020x, 27104030x, 27101050x, 27101030x, 27102030x, 27102050x, 27103030x, 27104050x, 27102020x	
Bolus		27104005x, 27104002x, 27104004x, 27101010x, 27101060x, 27102010x, 27102060x, 27103010x, 27103060x, 27104010x, 27104015x	
Premixed		27104080x, 27104070x, 27103070x, 27104090x	
Comorbidity			
Cardiac vascular disease	410.xx-414.xx, 429.2x		
Dyslipidemia	272.xx		
Hypertension	401.xx-404.xx		
Metabolic disorder medications			
Cardiovascular disease		8560x, 3210x, 8310x, 8320x, 8330x, 8333x, 8337x, 3940x, 8520x, 8515x, 6410x, 6499x	
Dyslipidemia		3910x, 3920x, 3930x, 3940x, 3945x, 3950x, 3999x	
Hypertension		3610x, 3615x, 3617x, 3620x, 3625x, 3630x, 3640x, 3660x, 3699x	

GPI = Generic Product Identifier; HCPCS = Healthcare Common Procedure Coding System; ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification.