

Patients Who Self-Monitor Blood Glucose and Their Unused Testing Results

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Self-monitoring of blood glucose (SMBG) has been advocated as a useful tool to help patients with type 2 diabetes mellitus (T2DM) and their healthcare providers to manage glycemia. For patients injecting insulin, SMBG can provide rapid feedback on glycemic levels and the pattern of results can often help guide insulin regimen adjustment over time. For patients not prescribed insulin, however, the clinical value of SMBG is less certain and remains controversial.^{1,2} For these patients, the American Diabetes Association (ADA) recommends regular glycated hemoglobin (A1C) testing, lifestyle interventions, and medication dose adjustment to achieve A1C-defined glycemic control. SMBG is suggested as a tool for patient education and self-management with “the frequency and timing ... dictated by the particular needs and goals of the patient.”³

Effective clinical use of SMBG among non-insulin-using patients requires that a patient be willing to take an active role in their diabetes care, receive sufficient self-management education to act appropriately on their results, and effectively communicate with healthcare providers about goals and results. Self-monitoring without the patient or physician using the results represents a breakdown in this process. Understanding the factors contributing to this breakdown may provide important insights into barriers to better diabetes care in general, and to more effective prescription of SMBG specifically.

For this analysis, we focused specifically on non-insulin-treated patients who self-monitored blood glucose. The purpose of our study was to identify factors associated with “worst case” ineffective SMBG use, defined as SMBG prescription without either the patient or the provider looking at the results. We hypothesized that patient factors (eg, lack of importance placed on diabetes control)⁴ and provider factors (eg, suboptimal communication)⁵ could increase the likelihood of self-monitoring without either the patient or provider using the results.

ABSTRACT

Objectives

To investigate the prevalence, predictors, and costs associated with unused results from self-monitoring of blood glucose (SMBG).

Study Design

Observational cohort study.

Methods

We studied 7320 patients with type 2 diabetes mellitus who were not prescribed insulin and who reported SMBG. Patients reported whether they used SMBG results to make adjustments to diet, exercise, or medicines; and whether their physician/provider reviewed their SMBG results. We categorized SMBG results as “used” (by patient and/or provider) or “unused” (not used by either patient or provider).

Results

SMBG results were unused by patient and provider in 15.2% of patients. In separate models adjusted for demographic and clinical differences, major predictors of SMBG without patient or physician using the results included a patient reporting that diabetes was not a high priority (relative risk [RR], 1.81; 95% CI, 1.58-2.07); the physician not engaging in shared decision making (RR, 1.66; 95% CI, 1.46-1.90); and no healthcare professional teaching the patient how to adjust diet/medicines based on SMBG results in the past year (RR, 2.27; 95% CI, 2.00-2.57). Patients with unused results were dispensed 171 ± 191 test strips per year at an estimated annual cost of \$168.

Conclusions

Nearly 1 in 6 non-insulin-treated patients practiced SMBG without either the patient or physician using the results. This represents a wasteful and ineffective practice for patients and health systems alike. Our results suggest that the decision to initiate and continue SMBG must be made in concert with the patient's own priorities, and, if prescribed, SMBG requires effective patient-provider communication and patient education.

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STUDY DESIGN AND METHODS

Participants and Setting

The study was conducted within Kaiser Permanente Northern California (KPNC), a nonprofit integrated healthcare delivery system that provides comprehensive medical care to a diverse population of approximately 3.4 million members. Distribution of patient demographic and socioeconomic factors is similar to that of the area population, except at the extremes of the income distribution.⁶

Survey Procedures and Patient Eligibility

The Diabetes Study of Northern California (DISTANCE) surveyed a race-stratified random sample of members of the KPNC Diabetes Registry.⁷ The DISTANCE survey assessed a range of social, behavioral, and care-related factors that might influence diabetes outcomes. The survey was in the field from 2005 to 2006 and had a response rate of 62%. (General information and the complete survey are available at <http://distancesurvey.org>.)

As part of the Diabetes and Aging Study (an ancillary study to DISTANCE), we analyzed adult survey respondents with T2DM not prescribed insulin who reported self-monitoring of blood glucose. Of 16,969 patients with T2DM who were asked SMBG questions, we excluded respondents who had less than 9 months of KPNC membership ($n = 73$), reported using insulin ($n = 3127$), had been with their current primary care physician for less than 1 year ($n = 2108$), had reported not using SMBG ($n = 2923$), or had missing responses to any of the 3 SMBG use questions ($n = 1373$). This left 7320 respondents eligible for analysis.

Categorization of Use of SMBG Results

Patient use of SMBG results was based on a “yes” response to either of the following 2 survey questions: “Based on readings from your home glucose tests do you: 1) adjust the dose or timing of diabetes medications? or 2) change when or what you eat or how much you exercise?” Provider use of SMBG results was defined by patient report that “during the past 12 months...your doctor or healthcare provider reviewed your own blood sugar test results” at every visit or most of the visits. We used this question with the logic that if the provider does not look at the results, he or she cannot use them to make changes in therapy. Based on responses to these questions, we categorized SMBG results as “used” (by patient or provider) or “unused” (results not used by patient

or provider). In this formulation, unused SMBG test results are those that are not used to guide any changes in patient behavior and are not consistently reviewed (and consequently not used) by their provider.

Patient and Provider Characteristics

The survey included validated measures to assess self-reported patient factors including demographics, health literacy,⁸ diabetes knowledge,⁹ depression,^{10,11} attitudes (eg, “taking care of my diabetes is a high priority for me right now”), and healthcare behaviors such as medication adherence,¹² smoking, and physical activity.¹³ Physical inactivity was defined as less than 3 days of vigorous activity (at least 20 minutes per day) or less than 5 days of moderate intensity activity (at least 30 minutes per day) per week. Provider factors included patient-reported trust in the provider¹⁴ and ratings of provider communication (eg, “how often did your personal physician involve you in making decisions about your healthcare as much as you wanted?” to assess shared decision making—a communication style that involves identifying a patient’s priorities and negotiating mutually agreed-upon care plans).¹⁵ Patient clinical and other demographic data were derived from administrative and clinical databases and linked to survey responses.⁷

We grouped characteristics into the following 5 thematic groups: 1) patient demographics; 2) clinical factors (eg, A1C level, diet management only vs treated with oral medications); 3) patient behavioral factors (eg, smoking, physical activity, and whether diabetes self-care was a priority); 4) provider factors (provider demographics, communication skills, and patient trust in provider); and 5) SMBG-specific education (including glucose goals and how to adjust their lifestyle or medications based on SMBG results).

Statistical Methods

We focused our analyses on the differences between patients with used versus unused SMBG results. Differences between respondent categories were compared using χ^2 tests, ANOVA, and t tests as indicated. For the 3 variables with the greatest difference in prevalence between patients who used versus did not use SMBG results, we constructed separate Poisson regression models using a log-link function and robust error variance to estimate the relative risk of unused SMBG results after adjusting for patient demographic and clinical variables (including treatment status). Use of modified Poisson models allowed us to estimate relative risks rather than odds ratios, which diverge from relative risk when

outcomes are not rare.¹⁶ We also created a combined multivariate model to estimate the fully adjusted relative risk of each key variable associated with unused SMBG results. Finally, after setting other model covariates to the overall cohort proportions by covariate categorical level, we used this multivariate model to estimate the population-based risk difference of unused SMBG results between populations with all versus none of the 3 most significant risk variables. SAS version 9.3 (SAS Institute, Inc, Cary, North Carolina) was used for all analyses in the study.

Based on the prevalence of “unused” SMBG results in our cohort, we also estimated the national cost consequences of unused SMBG results as the product of the annual average number of dispensed test strips in the group with unused SMBG results (based on pharmacy dispensing data) and wholesale test strip prices. We chose \$0.98 per strip as our test strip cost because this value has been used in the published literature.¹⁷ Other potential costs associated with SMBG practice such as glucometers and lancets were not included. The study was approved by the institutional review boards of the Kaiser Foundation Research Institute, University of Chicago, and University of California, San Francisco.

RESULTS

Cohort Characteristics

Among the 7320 patients in our study cohort, mean age was 58.7 ± 9.9 years and mean T2DM duration was 8.3 ± 7.1 years. Based on pharmacy dispensing records, patients were prescribed SMBG test strips for 4.6 ± 2.9 years prior to the survey. Patients had been seeing their primary care physician for 6.1 ± 4.3 years; most (85.2%) were prescribed oral medicines for glycemic control. The distribution of SMBG results, by category, was that 84.8% used the results (36.7% used by both patient and provider; 34.4% by patient only; 13.8% by provider only) and 15.2% were unused by patient or provider.

Patient Demographic, Clinical, and Behavioral Factors

A1C levels were slightly higher among patients with used versus unused SMBG results (7.3% [56 mmol/mol] vs 7.1% [54 mmol/mol]; $P < .001$). There were several other modest though statistically significant demographic and clinical differences between patient groups (Table 1). Years of SMBG use did not differ between groups ($P > .05$). Larger differences between patient groups were found in patient attitudes and health behaviors:

patients in the unused results group were more than twice as likely to rate diabetes as not being a high priority (17.9% vs 9.1% among patients whose SMBG results were unused vs used; $P < .001$) and patients with unused results were more likely to be physically inactive (42% vs 35.3%; $P < .001$).

Physician and Practice Factors

Physicians in this study were on average 44.8 ± 9.1 years old and had graduated from medical school 19.0 ± 9.2 years ago; 45% were women. There were no statistically significant differences in physician demographics between patients in the used versus unused SMBG results categories. However, there were substantive differences in how the 2 patient groups rated their physician’s interactions and communication (Table 2). The physician factor that stood out as markedly different was a lack of shared decision making: patients whose SMBG results were unused were less likely to report that their physician (or primary health provider) practiced shared decision making (55.2% vs 70.4%; $P < .001$).

Questions specific to SMBG education were framed as asking the patient if they had been taught how to adjust medication, diet, or exercise based on SMBG results in the last 12 months. Virtually all patients reported that a healthcare provider had talked about SMBG in the prior year (98.8%), but substantially fewer patients in the unused SMBG results category reported that a healthcare provider had specifically discussed glucose targets (65.8% vs 76.3% of patients in the unused vs used results group; $P < .001$) or how to adjust either their diet or medications in response to SMBG results (30% vs 56.5%; $P < .001$).

Multivariate Models

We modeled the relative risk of unused SMBG results based on the 3 variables that had the greatest difference between groups in the univariate analyses (see Table 3 for models). There was 85% greater risk of unused SMBG results among patients who reported that diabetes was not a high priority (RR, 1.85; 95% CI, 1.62-2.12). Adjustment for demographic and clinical differences had little effect on this estimate (Model 2: adjusted RR, 1.81; 95% CI, 1.58-1.97). Similarly, adjusted relative risk of unused SMBG results increased 66% (RR, 1.66; 95% CI, 1.46-1.90) if the patient reported that their physician did not engage in shared decision making, and by more than double (RR, 2.27; 95% CI, 2.00-2.57) if no healthcare provider had told them how to adjust their diet or medicines. When included together in a single fully adjusted model (Model 3), these 3 variables remained independently pre-

dictive of unused SMBG results, although with slightly attenuated relative risks. Overall, the estimated probability of having unused SMBG results would increase from 6% in a population with none of the 3 predictive factors to 32.4% in a population with all 3 predictive factors.

Estimate Cost Consequences of Unused SMBG Results

Patients with unused SMBG results were dispensed fewer SMBG test strips over the prior 2 years (342.2 ± 382.4) compared with patients with used results (447.2 ± 503.6 , $P < .001$). These unused SMBG results represent 171 ± 191 test strips dispensed per year at an estimated cost per patient of \$168 annually (based on a wholesale test strip price of \$0.98 per strip¹⁷).

DISCUSSION

Among patients in our cohort with T2DM not treated with insulin, nearly 1 in 6 (15.2%) reported that they performed SMBG without using the results to change their diet, activity level, or medications, and without their physician (or other primary health provider) regularly reviewing the results. This wasteful practice was associated with potentially modifiable diabetes management barriers at the patient, provider, and practice level.

The most important patient-level factor associated with unused SMBG results was patients reporting that their diabetes care was not a high priority. Self-management in diabetes is very complex and time-consuming,¹⁸⁻²⁰ and many patients with diabetes have multiple comorbidities and competing health demands.^{21,22} Effective primary care for these patients requires addressing multiple behavioral and clinical issues, both diabetes- and non-diabetes-related.^{23,24} When SMBG is prescribed to patients for whom taking care of their diabetes is not a high priority, our results demonstrate that the likelihood of unused SMBG results nearly doubles, suggesting that the decision to prescribe SMBG should be made by the patient and provider together with the patient's overall health priorities in mind, and this decision should probably be reevaluated on a regular basis as other health issues arise or resolve. In addition, it has been suggested that ineffective implementation of SMBG (eg, asking patients to monitor their blood glucose without clinicians using the results) could lower patients' motivation for self-management.²

Patients with unused SMBG results were much less likely to report that their provider practiced shared decision making. Other measures of suboptimal patient-

centered communication (provider listening, explaining, taking time, and patient trust in provider) had similar though smaller associations with unused SMBG results. In a previous study in this same population, patients who were dissatisfied with their provider's communication or had low trust in their provider were less likely to follow instructions for prescribed medications.²⁵ Taken together, these results emphasize the critical role of ongoing communication between patients and providers in effective diabetes management.

Providing explicit instructions about interpreting and acting on SMBG results, a role typically carried out by diabetes educators, had marked impact on whether SMBG results were used. While virtually all patients in our analytic cohort reported that a healthcare provider had talked to them about SMBG in the prior year, two-thirds of patients with unused results reported that no provider had specifically instructed them in how to use their SMBG results to make diet, exercise, or medication adjustments. This finding supports the concept that prescription of SMBG is not likely to be useful if it is not linked to educational support. Prior studies underscore the need for effective and often intensive self-management education in how to use SMBG results.^{26,27} However, while education is necessary, it is clearly not sufficient, as one-third of patients with unused SMBG results reported that they had been taught how to make adjustments in the prior year. Taken together, these results suggest that effective SMBG use requires a combination of patient prioritization of active self-management, good patient-provider communication, and a clinical setting that can support self-management education.

Why were these patients testing their glucose without using the results? Our study was not designed to directly answer this question, but prior work by our group suggests that any value related to SMBG may accrue primarily during the initial period after monitoring has been started or restarted, and that this benefit attenuates over time.²⁸ Thus, continuing to prescribe SMBG test strips without actively discussing the results, or without patients using the results, may be a form of clinical inertia. In these patients, there may be a habit of self-monitoring that extends beyond the period of active use and/or usefulness of the results. Similarly, providers who prescribe SMBG but do not review the results may assume, often erroneously, that the patient is using the results for self-management. One recent study found that 30% of patients were reluctant to discuss self-care with their providers,²⁹ and another study found poor agreement between glucose diaries and meter memories,³⁰ indicating

that there may be a disconnect between what the patient tells the provider and what the patient is actually doing.

Patients in the unused SMBG results group had reasonably good glycemic control and slightly lower A1C levels compared with patients whose SMBG results were used. Although our study was designed to identify factors associated with unused SMBG results, the similarity of A1C levels in our 2 comparison groups suggests no negative clinical consequences of SMBG results unused in patients with non–insulin-treated T2DM. Indeed, for most of these patients, SMBG was clearly not necessary to achieve good glycemic control.

The overall rate of SMBG in the United States has been increasing (from 40.6% in 1997, to 63.4% in 2006) among adults with diabetes in all age groups (~3% increase per year).³¹ Nearly three-fourths of these patients are not prescribed insulin. Extrapolating the 15.2% prevalence of patients with unused SBMG results found in our cohort to the national population of non–insulin-treated patients, we estimate that as many as 300 million test strips are wasted each year at an approximate cost of \$294 million. Using a lower per strip price would, of course, lower this overall estimate. Nonetheless, our calculation represents a conservative estimate of waste, since our study was not designed to assess the clinical benefit of strips used in the 84.8% of patients and/or providers in our cohort who did review SMBG results.

To our knowledge, this study is the first to use a large-scale patient survey to investigate patient-, provider-, and practice-level predictors of unused SMBG results in patients not taking insulin. The strengths of our study include robust survey methods in a large, racially and ethnically diverse patient population. Our results must be interpreted within the limits of the study design. Survey data (including SMBG use) are self-reported and thus potentially subject to reporting biases. However, the questions related to SMBG were embedded within a much larger survey, so patients were unaware of the study hypothesis (reducing the risk of systematic response bias). Also, data are from a cross-sectional survey combined with longitudinal retrospective data on utilization, and thus we cannot infer causality from the factors associated with unused SMBG results. Indeed, our goal was not to address the clinical utility of SMBG, but rather to understand the factors associated with the wasted effort of unused results. An additional limitation is that some patients may have responded that they did not use SMBG results because their results were always in range. However, given that patients were prescribed SMBG for an average of 4.6 years, we consider it highly

unlikely that no readings would be out of range during that extended period of use. Finally, our study was conducted among members of an integrated health plan, and thus may not reflect SMBG practice patterns or use of SMBG results in other settings. Because patients in an integrated care system may have more coordinated care than patients in other settings, our results may potentially underestimate the national prevalence of unused SMBG results, while overestimating the prevalence of SMBG practice. Nonetheless, the factors we identified that predict patterns of unused SMBG results are likely widely generalizable.

CONCLUSIONS

SMBG does not itself lower blood glucose, but rather serves as a tool to monitor health status and facilitate glucose-lowering interventions (eg, pharmacotherapy, behavioral changes). The utility of this costly, time-consuming, and sometimes painful procedure depends on whether it is used effectively to modify care, either through changes in patient self-management activities or in management by the provider, and whether it leads to better outcomes. The American Diabetes Association, International Diabetes Federation, and other groups recommend making the decision to prescribe SMBG on an individual basis and only after mutual agreement between the patient and the provider.^{3,32} Our results support the concept that SMBG may not be appropriate for all patients. When diabetes is not a high priority, patients are less likely to make effective use of SMBG results. In these cases, the focus of care should be on discussing the patient's priorities and developing a shared plan for care that may or may not include SMBG. Our findings support the recommendation that the decision to prescribe SMBG should include assessment of the patient's priorities, use a shared decision-making approach, and, if prescribed, be closely linked to an effective self-management educational program and repeated discussions about whether patients are using results.

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Take-Away Points

Nearly 1 in 6 non-insulin-treated patients with diabetes self-monitor their blood glucose without either the patient or provider using the results. Key factors associated with unused results include patients not considering diabetes a high priority, physicians not engaging in shared decision making, and care teams not teaching the patient how to adjust diet/medicines based on glucose results.

- These findings reveal several potential barriers to effective diabetes management.
- Testing without using the results represents a significant waste of resources.
- The decision to prescribe glucose self-monitoring should be carefully considered and may need to be reevaluated over time.

■ **Table 1.** Patient Characteristics Categorized by Use of SMBG Results (n = 7320)

	SMBG Results Used ^a (n = 6210)	SMBG Results Unused ^b (n = 1110)	P
Patient demographics (n [%] unless otherwise noted)			
Female	3117 (50.2)	523 (47.1)	.06
Age			
Mean, years (SD)	58.5 (9.9)	59.9 (9.8)	<.001
Categorized: ≥65 years	1874 (30.2)	392 (35.3)	<.001
Race/ethnicity			
African American	1066 (17.2)	183 (16.5)	<.01
Asian	1485 (23.9)	255 (23.0)	
Latino	1154 (18.6)	167 (15.1)	
White	1540 (24.8)	329 (29.6)	
Multi/other	913 (14.7)	168 (15.1)	
Missing	52 (0.8)	8 (0.7)	
Education			
Didn't complete high school	813 (13.1)	169 (15.2)	<.01
High school/GED	1718 (27.7)	352 (31.7)	
Some college (or more)	3563 (57.4)	574 (51.7)	
Missing	116 (1.9)	15 (1.4)	
Employment status			
Employed	3426 (55.2)	572 (51.5)	.07
Not employed	2692 (43.4)	523 (47.1)	
Missing	92 (1.5)	15 (1.4)	
Annual income			
<\$65,000	3268 (52.6)	594 (53.5)	.13
≥\$65,000	2342 (37.7)	391 (35.2)	
Missing	600 (9.7)	125 (11.3)	
Health Literacy			
Inadequate ^c	934 (15.0)	181 (16.3)	.41
Adequate	5130 (82.6)	899 (81.0)	
Missing	146 (2.4)	30 (2.7)	
Clinical characteristics (n [%] unless otherwise noted)			
A1C			
Mean % (SD), [mmol/mol (SD)]	7.3 (1.4), [56 (15.3)]	7.1 (1.5), [54 (16.4)]	<.001
≥9.0	596 (9.6)	88 (7.9)	
No A1C test	547 (8.8)	137 (12.3)	
Diabetes duration, years (SD)	8.3 (7.1)	8.0 (6.8)	.19
Outpatient visits prior year, mean (SD)	7.5 (8.3)	7.5 (8.9)	.80
Diet-only management^d	970 (15.6)	220 (19.8)	<.001

(continued)

■ **Table 1.** Patient Characteristics Categorized by Use of SMBG Results (n = 7320) (continued)

	SMBG Results Used ^a (n = 6210)	SMBG Results Unused ^b (n = 1110)	P
Self-reported depression symptoms			
None	3698 (59.6)	645 (58.1)	.28
Mild-moderate	1653 (26.6)	287 (25.9)	
Major-severe	216 (3.5)	46 (4.1)	
Missing	643 (10.4)	132 (11.9)	
Health Behaviors [n (%)]			
Diabetes is a high priority:			
No	564 (9.1)	195 (17.6)	<.001
Yes	5570 (89.7)	896 (80.7)	
Missing	76 (1.2)	19 (1.7)	
Physical activity			
Insufficiently active ^c	2189 (35.3)	466 (42.0)	<.001
Sufficiently active	1260 (20.3)	239 (21.5)	
Highly active	2715 (43.7)	390 (35.1)	
Missing	46 (0.7)	15 (1.4)	
Smoking status			
Never	3436 (55.3)	575 (51.8)	.09
Former/current	2673 (43.0)	517 (46.6)	
Missing	101 (1.6)	18 (1.6)	
Not fully medication adherent, self-report^f	1348 (25.3)	238 (26.1)	.6
Poor medication adherence^g			
No	3592 (57.8)	621 (56.0)	<.01
Yes	1703 (27.4)	283 (25.5)	
Cannot calculate	915 (14.7)	206 (18.6)	
A1C indicates glycated hemoglobin; SMBG, self-monitoring of blood glucose.			
^a SMBG "results used" is defined as patient making changes to dose/timing of diabetes medication, diet, or exercise based on SMBG results; and/or that patient reports that doctor or healthcare provider reviewed SMBG results at all or most visits during past 12 months.			
^b SMBG "results unused" is defined as neither patient nor provider utilizing SMBG results.			
^c Inadequate literacy defined as a score <10 on literacy scale.			
^d No evidence of pharmacy prescriptions filled for glycemic control medications in year prior to survey date.			
^e Insufficiently physically inactive defined as less than 3 days of vigorous activity (at least 20 minutes) or less than 5 days of moderate intensity activity (at least 30 minutes), weekly.			
^f Missed pills at least 1 day out of 7 among those self-reporting diabetes medication use (n = 6245).			
^g Gaps in diabetes-related medications on >20% of days in year prior to survey date.			

■ **Table 2.** Patient-Reported Provider Traits and SMBG Education, Categorized by Use of SMBG Results

	SMBG Results Used ^a (n = 6210)	SMBG Results Unused (n = 1110)	P
Patient-reported PCP traits [n (%)]^b			
Shares decision making			
Yes	4370 (70.4)	613 (55.2)	
No	1111 (17.9)	271 (24.4)	<.001
Missing	29 (11.7)	226 (20.4)	
Understands problems			
Yes	3993 (64.3)	604 (54.4)	
No	604 (9.7)	126 (11.4)	<.001
Missing	1613 (26.0)	380 (34.2)	
Takes time			
Yes	4860 (78.3)	755 (68.0)	
No	721 (11.6)	146 (13.2)	<.001
Missing	629 (10.1)	209 (18.8)	
Is trustworthy			
Yes	5219 (84.0)	834 (75.1)	
No	441 (7.1)	102 (9.2)	<.001
Missing	550 (8.9)	174 (15.7)	
Listens well			
Yes	5092 (82.0)	792 (71.4)	
No	505 (8.1)	108 (9.7)	<.001
Missing	613 (9.9)	210 (18.9)	
Explains well			
Yes	5005 (80.6)	783 (70.5)	
No	600 (9.7)	123 (11.1)	<.001
Missing	605 (9.7)	204 (18.4)	
HCP has discussed SMBG^c			
Yes	6142 (98.9)	1090 (98.2)	
No	31 (0.5)	15 (1.4)	<.01
Missing	37 (0.6)	5 (0.5)	
HCP has set target for blood sugar			
Yes	4738 (76.3)	730 (65.8)	
No	1406 (22.6)	361 (32.5)	<.001
Missing	66 (1.1)	19 (1.7)	
HCP has discussed how to adjust medicine or diet			
Yes	3506 (56.5)	333 (30.0)	
No	2320 (37.4)	603 (54.3)	<.001
Missing	384 (6.2)	174 (15.7)	

HCP indicates healthcare provider; PCP, primary care physician; SMBG, self-monitoring of blood glucose.
^aSMBG “results used” is defined as patient making changes to dose/timing of diabetes medication, diet, or exercise based on SMBG results; and/or that patient reports that doctor or healthcare provider reviewed SMBG results at all or most visits during past 12 months.
^bPatient-reported PCP traits: response of “always or usually” = yes; “sometimes or never” = no. Patients reporting no visit with PCP in prior 12 months = missing.
^c“HCP has discussed SMBG” means education by any HCP, not only PCP.

■ **Table 3.** Relative Risk of Unused SMBG Results in Multivariate Models

Key Variable	Model 1	Model 2	Model 3
DM not a priority ^a	1.85 (1.62-2.12)	1.81 (1.58-2.07)	1.70 (1.46-1.99)
PCP does not SDM ^b	1.59 (1.40-1.82)	1.66 (1.46-1.90)	1.49 (1.30-1.70)
No SMBG adjustment ^c	2.38 (2.10-2.70)	2.27 (2.00-2.57)	2.18 (1.91-2.50)

DM indicates diabetes mellitus; PCP, primary care physician; SDM, shared decision making; SMBG, self-monitoring of blood glucose.

^aPatient does not place a high priority on their diabetes (missing n = 95).

^bPatient reports that PCP shares in decision making “sometimes” or “never” (missing n = 955).

^cPatient reports no healthcare provider explained how to adjust lifestyle or medicines in response to SMBG results in the prior year (missing n = 558).

Model 1: Unadjusted models for each of the 3 key variables; $P < .001$ for all estimates shown.

Model 2: Individual models for each of the 3 key variables adjusted for age, gender, race, education, employment, A1C, DM treated by diet only versus medications, and level of physical activity; $P < .001$ for all estimates shown.

Model 3: A single combined model adjusting for all Model 2 factors plus the 3 key variables; $P < .001$ for all estimates shown.

Parentheses indicate 95% CI.