Reduction in Self-Monitoring of Blood Glucose in Persons with Type 2 Diabetes Results in Cost Savings and No Change in Glycemic Control

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Objective: Recent Veterans Affairs (VA) guidelines recommend that persons with stable type 2 diabetes controlled on oral agents or diet therapy perform self-monitoring of blood glucose (SMBG) twice weekly. We assessed the impact of a modification of these guidelines on hemoglobin A_{1c} (HbA_{1c}) and monitoring cost.

Study Design: Retrospective, noncrossover clinical trial.

Patients and Methods: We instructed persons with type 2 diabetes to perform SMBG testing according to modified adapted VA guidelines. We compared patients' baseline average testing frequency and HbA_{1c} with those obtained during a 6-month interval beginning 2 months after implementation of the modified guidelines. The impact on the cost of monitoring was calculated.

Results: At baseline, 913 of 1213 SMBG users with diabetes on oral hypoglycemic agents had HbA_{1c} tested (HbA_{1c}= 7.83% ± 1.34%); their frequency of SMBG was 1.36 ± 0.95 strips per patient per day. Postimplementation, 974 of 1278 persons with diabetes had HbA_{1c} tested (HbA_{1c} = 7.86% ± 1.54%; P = .63 vs baseline); frequency of SMBG decreased by 46% to 0.74 ± 0.50 strips per patient per day (P < .0001). At baseline, 154 of 254 SMBG users with diabetes on diet therapy had HbA_{1c} tested (HbA_{1c} = 6.85% ± 0.97%); their frequency of SMBG was 1.07 ± 0.90 strips per patient per day. Postimplementation, 177 of 282 diet-treated persons with diabetes had HbA_{1c} tested (HbA_{1c} = 6.78% ± 1.20%; P = .56 vs baseline); frequency of SMBG decreased by 35% to 0.70 ± 0.51 strips per patient per day (P < .0001). Similar findings were observed in a cohort of 421 drug-treated patients with paired HbA_{1c} data before and after implementation, and a cohort of 50 diet-treated patients with paired HbA_{1c} data. Linear regression analysis showed no significant impact on individuals' HbA_{1c} with reduction in strip use. Average monthly cost savings were $8800, or $6.37 per patient per month.

Conclusions: This program decreased the frequency of SMBG in persons with type 2 diabetes, resulting in substantial cost savings without affecting glucose control.

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Self-monitoring of blood glucose (SMBG) has evolved over the last 15 years to become the standard of care for type 1 diabetes. In type 2 diabetes, uncertainty remains concerning the role of SMBG, and American Diabetes Association (ADA) guidelines focus on individual patient needs.[1,2] In this era of managed care, health plan administrators attempt to provide high-quality, cost-effective healthcare despite budgetary pressures. As the nation's largest health maintenance organization, the Department of Veterans Affairs (VA) is faced with the same pressures, exacerbated in part by an aging population with significant comorbidities. The prevalence of diabetes has been estimated to be 12% in the VA; this population accounts for 24% of pharmacy costs.[3]

The VA Northern California Health Care System (VANCHCS) includes 7 outpatient clinics with a geographic catchment area of more than 60,000 square miles, and a narrow spectrum of mostly lower socioeconomic patients from rural, suburban, and urban settings. Of approximately 35,000 patients seen annually, approximately 4000 have diabetes that is treated pharmacologically (receiving medication and/or testing supplies), about 95% of whom have type 2 diabetes. These patients with diabetes are evaluated on a regular basis by either a primary care provider or an endocrinologist, and at least annually by a certified diabetic educator,

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for reinforcement of strip technique, review of indices of diabetic control and complications, and modification and education of lifestyle and pharmacologic therapy.

In 1997, VANCHCS spent approximately $450,000 on glucose testing strips. Our meter of choice is the AccuChek Advantage (Boehringer Mannheim, Indianapolis, IN). Diabetes educators train all patients in correct use of strips. Because of the high cost of these strips and the lack of data regarding their optimal use, we implemented an adaptation of recommendations proposed by a VA Medical Advisory Panel—a policy of 50 strips for 90 days—in April 1998 for stable patients with type 2 diabetes who were not receiving insulin. We then assessed whether we could affect cost savings by reducing strip use without compromising glucose control.

··· SUBJECTS AND METHODS ···

Our population comprised patients receiving SMBG strip prescription fills, documented in the local installation of the Veterans Health Information System and Technology Architecture (VISTA) database. We previously reported on the utility of computerized VA databases as a means of identifying patients with diabetes mellitus and assessing their quality of care.[4–10] We included patients receiving an SMBG strip prescription fill between July 1 and December 31, 1997, for the baseline period, and between July 1 and December 31, 1998, for the postimplementation period. Strip use was calculated from prescription fill data extracted from VISTA. Strip use frequency was calculated by determining the number of strips issued per prescription during the review period, and dividing this number by the days within the time frame (180 days). Thus, if a patient received 2 prescriptions for 50 strips, the result would be 100/180, or 0.56 strips per day. We assumed that this prescription fill rate corresponded to the actual use rate. To provide data on diurnal glycemic profiles with a limited number of strips, patients were instructed to rotate the time of day for performing SMBG.

Patients receiving oral hypoglycemic prescription fills were identified from the VISTA database during the defined study periods; diet-treated patients were identified by strip use without prescription fills for oral hypoglycemic agents or insulin. We excluded patients receiving insulin during or within 3 months before or 2 months after the study periods.

We analyzed both a global population, consisting of all patients receiving strips (medication- or diet-treated), whether or not they had hemoglobin A_{1c} (HbA_{1c}) determined, and a cohort of patients receiving strips who were tested for HbA_{1c} both before and after implementation of the policy. HbA_{1c} test values were averaged for those patients having more than 1 test in the pre- or postimplementation periods. The cohort included patients who were receiving oral hypoglycemic agents only, and patients who were diet-treated who did not receive oral hypoglycemic agents during the study. The study was approved by the Institutional Review Board, and was exempted from informed consent.

The policy to change the frequency of SMBG was initiated by means of a letter sent in April 1998 to 1467 oral agent- or diet-treated diabetic patients receiving strips. All patients receiving insulin were excluded. Pharmacists changed prescriptions for SMBG strips to 50 strips for a 90-day period. The implementation was immediate and refill dates and quantities were calculated accordingly. Patients with concerns or questions were instructed to contact the signatories of the letter, their diabetes educators, or their primary care providers. Patients enrolled after the policy went into effect were advised of the policy during routine primary care or pharmacy encounters. Patients who required more strips either for observation of changes in their treatment regimen, monitoring and management of asymptomatic hypoglycemia, or to help them manage sick days were able to receive additional strips by having their providers overwrite the policy with a notation on their prescription. No patients were excluded from the policy change or analysis based solely on glycemic control. However, if recent medication addition or titration was noted for an individual patient, the provider was contacted regarding suitability of patient inclusion prior to making the change in strip use.

HbA_{1c} was used as the index of glycemic control in keeping with both the Diabetes Control and Complications Trial[11] and previous work from our group.[4,7,8,10] HbA_{1c} was measured throughout the study in the VANCHCS reference laboratory at Martinez, California, by ion-exchange high-performance liquid chromatography (HPLC). The automated Bio-Rad Variant analyzer (Bio-Rad, Hercules, CA) was used during the baseline phase through the first 3 months of the implementation phase, and the automated Tosoh A_{1c} 2.2 Plus Glycohemoglobin analyzer (Tosoh Medics, Inc, Tokyo, Japan) during the last 3 months of this phase. These 2 analyzers use

essentially the same ion-exchange HPLC methodology, but recommended normal ranges differ slightly (4.1% to 6.5% for the Variant, 4.1% to 6.2% for the Tosoh). Published data indicate a close correlation between results from these 2 analyzers.[12] Direct split-sample comparison in our laboratory of HbA_{1c} values using these analyzers in 82 consecutive samples submitted at the time of changeover showed a high degree of linear correlation; $r = .990$ ($P < .001$). Mean HbA_{1c} in these samples was 7.68% ± 0.18% SE using the Variant analyzer, and 7.32% ± 0.17% for the Tosoh ($P < .001$; 2-tail paired t test), a difference of –0.36%. The conversion equation was Tosoh% = (0.9649)(Variant%) – 0.0918%.

Although evidence indicates that the use of conversion factors is valid for different HPLC-based methodologies,[13,14] we chose to present the unadjusted data, recognizing that in populations with differing renal function and complex, unstable clinical status, conversion factors are still only approximate. For comparison, we measured the simultaneous change in mean HbA_{1c} in nonstudy diabetic individuals in our clinic for 3 months before the changeover and 3 months afterward: Their HbA_{1c} decreased from 8.27% ± 0.05% (n = 1080) to 8.04% ± 0.05% (n = 780; $P < .01$). Thus, the 3 estimates for the magnitude of change are comparable: –0.3%, –0.36%, and –0.23%. Because these values apply only to the second half of the postimplementation phase, we estimate that the methodology change would have lowered mean HbA_{1c} reported for the postimplementation period by only 0.1% to 0.2%, a relatively insignificant change clinically. Finally, we also report the adjusted HbA_{1c} data for the cohort of 421 hypoglycemic-treated patients who had both pre- and postintervention HbA_{1c} tests.

Glycemic control in SMBG users was also compared with that of SMBG nonusers. We retrospectively analyzed an available VISTA database on HbA_{1c} for individuals receiving at least 1 prescription for oral agents, but not insulin, between July 1, 1997, and June 30, 1998. For purposes of this retrospective analysis, users of SMBG were defined as individuals who filled at least 1 prescription for blood glucose (BG) strips within the 1-year interval; nonusers did not have any BG strip prescription fills for the same time frame. It should be noted that the retrospective study dates partially overlap those of our interventional study; users on oral agents at the baseline of the interventional study were also included in the retrospective analysis group.

Cost savings were calculated as the difference between the observed monthly cost of strips after the intervention, and the expected monthly cost had the intervention not taken place. The expected monthly cost was calculated by multiplying the number of patients with diabetes receiving strips by the prepolicy rate of strip use.

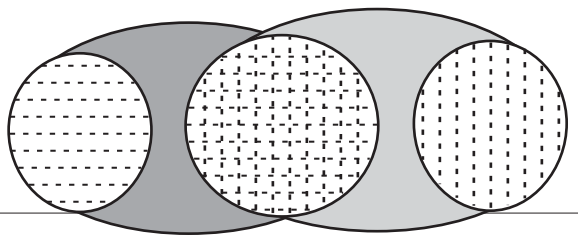
Personal computers using Access databases and Excel spreadsheets (Microsoft, Redmond, WA) were used to calculate data. Student t test was used for the global analysis, while paired t tests were used for the cohort analysis. $P < .05$ was considered significant.[15] Data are shown as mean ± SD.

··· RESULTS ···

Figure 1 provides a scheme of the global and cohort populations; these terms apply to both the pharmacologically treated and the diet-treated patients. Of all patients in our system receiving oral hypoglycemic agents, about two thirds performed SMBG; of those, 76% had HbA_{1c} determined during the baseline time interval (patients in VANCHCS receiving oral hypoglycemic agents who did not perform SMBG are not shown). This population of patients using SMBG strips, whether or not they had HbA_{1c} determined, was referred to as the "global" population. Although the patient numbers after implementation were larger, the proportions of SMBG testers and patients with HbA_{1c} testing remained the same. There was a comparable global population of diet-treated patients, of whom about two thirds had HbA_{1c} performed, with a corresponding increase in patient numbers over time. A cohort of 421 oral hypoglycemic-treated patients was identified who used SMBG strips and had HbA_{1c} tested during the baseline and the postimplementation periods. Similarly, a cohort of 50 diet-treated patients was identified who used SMBG strips and had HbA_{1c} tested during the baseline and postimplementation periods. These cohort populations were included to control for any bias from patient movement in and out of the global population and incomplete HbA_{1c} testing.

Table 1 shows the demographics of the study population. No significant differences were noted in demographic features between the different groups within the study populations, and between the study populations and the (non–insulin-treated) diabetic population at large (P = NS, Student t test, data not shown). **Table 2** shows the distribution of oral medications used by the global population. Most patients (~90%) were on sulfonylureas and about 40% received metformin. Smaller percentages were using

Figure 1. Schematic of the Study Groups



Group	Subjects performing SMBG:	Oral hypoglycemics	Diet
A	SMBG during baseline, not during postimplementation; HbA_{1c} not obtained	300	100
B	SMBG during baseline, not during postimplementation; HbA_{1c} during baseline only	492	104
C	SMBG and HbA_{1c} value at both baseline and postimplementation, "Cohort"	421	50
D	SMBG postimplementation, not at baseline; HbA_{1c} postimplementation only	553	127
E	SMBG postimplementation, not at baseline; HbA_{1c} not obtained	304	105
	Baseline "global" group = A + B + C	1213	254
	Postimplementation "global" group = C + D + E	1278	282

Schematic is not drawn to scale. Five groups of individuals are represented: (A) Subjects performing self-monitoring of blood glucose (SMBG) during baseline without hemoglobin A_{1c} (HbA_{1c}) testing at baseline and not in follow-up (n = 300 for medication-treated patients and 100 for diet-treated patients); (B) Subjects performing SMBG with HbA_{1c} testing at baseline, but not in follow-up (n = 492 for medication and 104 for diet-treated patients); (C) Subjects performing SMBG with HbA_{1c} testing both at baseline and follow-up (["cohort"] n = 421 for medication- and 50 for diet-treated patients); (D) Subjects performing SMBG but with HbA_{1c} testing only at follow-up (n = 553 for medication- and 127 for diet-treated patients); and (E) Subjects performing SMBG without HbA_{1c} testing at follow-up and not present at baseline (n = 304 for medication- and 105 for diet-treated patients). Patients performing SMBG, with or without HbA_{1c} testing, are referred to as the "global" population, and further defined based on baseline or follow-up status and medication or diet treatment. Baseline "global" group = A + B + C (n = 1213 for medication- and 254 for diet-treated patients); postimplementation "global" group = C + D + E (n = 1278 for medication- and 282 for diet-treated patients). See text for details.

acarbose, troglitazone, and other agents. Although the proportions using most oral agents did not change significantly after implementation of the modified guidelines, the proportion of individuals using troglitazone increased significantly ($P < .0001$, Student t test). Most patients in the study were taking multiple medications simultaneously. The cohort had a comparable distribution of medication use (data not shown).

Figure 2 shows the reduction in strip use in both medication- and diet-treated patients, for the global and cohort populations. The decrease was significant in all groups, and approached 50% in some instances (global drug-treated: 1.36 ± 0.95 strips per day at baseline to 0.74 ± 0.5, $P < .0001$; global diet-treated: 1.07 ± 0.90 to 0.70 ± 0.51, $P < .0001$; cohort drug-treated: 1.35 ± 0.92 to 0.67 ± 0.44, $P < .001$; and cohort diet-treated: 1.17 ± 1.04 to 0.61 ± 0.44, $P < .001$). The average daily strip use was almost 0.7 per day after implementation, in excess of the 0.56 strip/d that would be expected with complete adherence to the 50 strip for 90-day policy. This higher strip use reflects the willingness of providers and pharmacists to respond to patient needs for an increase in strip allotments.

The impact of the reduction in strip use on HbA_{1c} is shown in **Figure 3**. For medication- and diet-treated patients in both the global and the cohort populations, changes in frequency of strip use had no effect on glycemic control. A slight but statistically significant improvement was noted in the uncorrected HbA_{1c} values in the medication-treated cohort population (baseline: 7.82 ± 1.22 vs post: 7.66 ± 1.17, $P < .05$), which may be at least in part attributable to the change in analyzers used in measuring HbA_{1c} (see Methods). However, when we applied the empiric conversion equation to this medication-treated cohort, there was no significant change in HbA_{1c} (baseline: 7.82 ± 1.22 vs post: 7.83 ± 1.21, NS). Patients who performed SMBG and who had HbA_{1c} measured, used strips at the same rate as those who did not have HbA_{1c} measured. Also, in this subgroup

(n = 421), only 24 (6%) were started on troglitazone after the preimplementation period, suggesting no major impact from the relatively new agent in this population.

To further assess the safety of our strip use reduction policy, we evaluated individuals in the cohort populations for a possible impact of changes in strip use frequency on glycemic control, as manifested by HbA_{1c}. **Figure 4** shows the linear regression obtained by plotting the slope of HbA_{1c} as a function of changes in strip use frequency for type 2 diabetic patients receiving medication. The figure shows no significant impact on individual glycemic control. Similar results were obtained for diet-treated patients (data not shown).

Based on prescription fill data to assess strip use, patients who performed SMBG at all had substantially lower HbA_{1c} (7.84 ± 0.04; n = 1055 compared with 8.27 ± 0.05; n = 897) than those who did not ($P < .0001$) at baseline.

The intervention resulted in a calculated savings of $8800 per month, even taking into account patient accrual and the resulting increase in the pool of patients with diabetes receiving strips. This amount translates into a savings of $6.37 per patient per month.

Table 1. Clinical Characteristics of the Study Populations

Parameter	Baseline	Postimplementation
Total population (N)	1467	1560
Diet treated (n)	254	282
Oral hypoglycemic treated (n)	1213	1278
Cohort (N)	471	471
Diet treated (n)	50	50
Oral hypoglycemic treated (n)	421	421
Age, mean ± SD (y)	64 ± 11	64 ± 11
Sex (% male)	98	98

There were no significant differences between baseline and postimplementation in terms of age or sex distribution.

Table 2. Oral Hypoglycemic Distribution for Global Population With Documented HbA_{1c}*

	Baseline (n = 913)	Postimplementation (n = 974)
Sulfonylurea	799 (88)	854 (88)
Acarbose	13 (1.4)	16 (1.6)
Metformin	361 (40)	422 (43)
Repaglinide	0	1 (0.1)
Troglitazone	35 (4)	81 (8.3)

*Values are number (percentage).

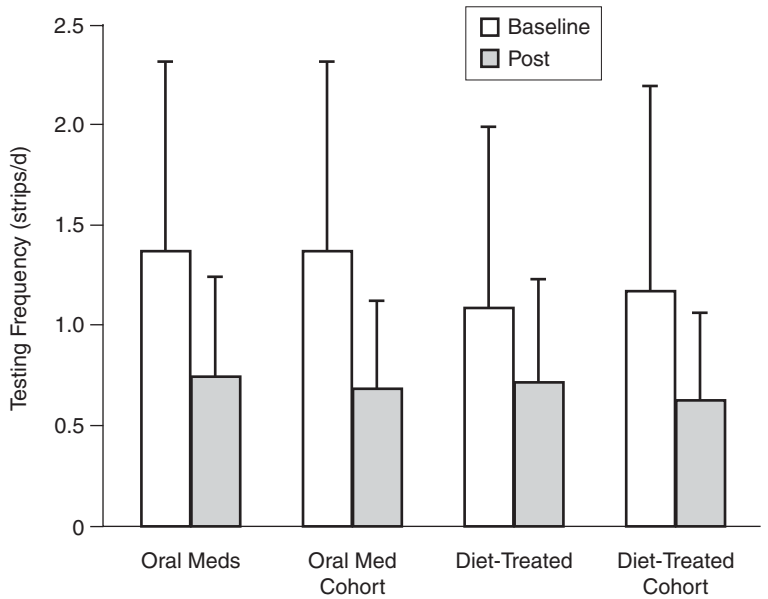
··· DISCUSSION ···

Our intervention, jointly undertaken by general internists, pharmacists, diabetes nurse educators, and endocrinologists, resulted in a substantial reduction in strip use with concomitant financial savings and without compromise of glycemic control. These findings are similar to those reported by Rindone[16] in a similar, albeit substantially smaller, strip use reduction program and to an earlier noninterventional study showing glycemic control being unrelated to strip use frequency.[17] However, in contrast to these studies, we found that medication- or diet-treated patients with type 2 diabetes who performed SMBG have significantly better glycemic control, as assessed by HbA_{1c}, than those who do not. This latter finding supports the VA Cooperative Study, which clearly showed SMBG to be of value in insulin-treated patients with type 2 diabetes in pursuit of tight glycemic control.[18]

Other investigators have reported no clear advantage to SMBG in non–insulin-using patients with type 2 diabetes[19–26] or as a modality to improve weight loss in obese patients with type 2 diabetes.[27] Many potential explanations could be given for the improved glycemic control observed in our patients who performed SMBG, including aggressive use of multiple oral hypoglycemic agents. The ADA guidelines strongly support the use of blood glucose testing in type 2 diabetes, but state that the frequency of such testing should be "sufficient to facilitate reaching glucose goals."[2]

What are the potential advantages of SMBG? Motivated patients get feedback on the consequences of their behavior, such as diet and exercise, on glucose control, and can therefore make appro-

Figure 2. SMBG Testing Frequency in Study Populations



Data shown as mean ± SD. SMBG = self-monitoring of blood glucose.

priate modifications based on individual responses to diet and activity challenges. Additionally, providers who encourage SMBG emphasize, by their actions, the importance of glycemic control that may be enhanced by a consistent lifestyle, including diet and exercise. Weinberger et al[28] reported that good glycemic control may be promoted by convincing patients of perceived benefits when following complex regimens. This educational emphasis is analogous to routine foot examinations: eventually patients learn the importance of inspection and foot hygiene, perhaps accounting in part for the dramatic decline in diabetes-related amputations.[29] Self-monitoring of blood glucose can also help patients identify why they feel poorly in a given situation by allowing them to distinguish between hypoglycemia and angina, eg, as a cause of diaphoresis or disturbed sleep.

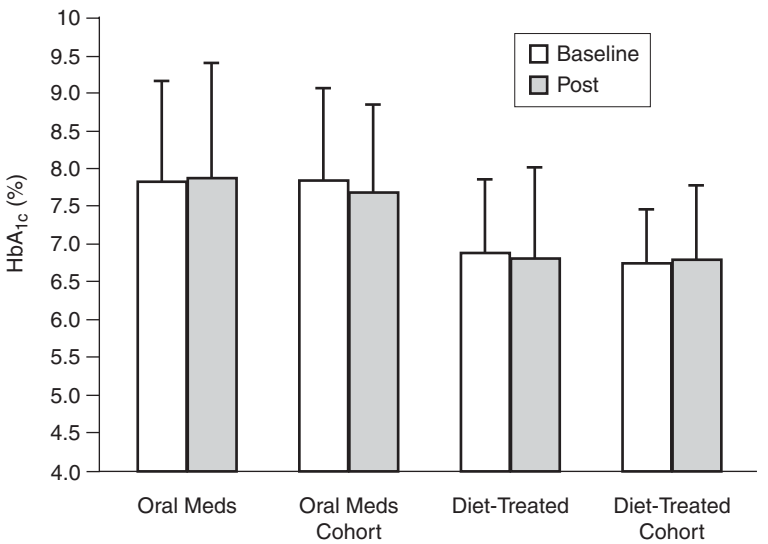
Self-monitoring of blood glucose allows for the adjustment of medications. For example, SMBG can show diurnal patterns of glycemia that allow the patient to match medications to meals and activity, and provides the opportunity to change a regimen without waiting for HbA_{1c} measurements. When there is discrepancy between laboratory fasting glucose and HbA_{1c} values, SMBG can also help guide the physician to make appropriate medication adjustments. Further studies should carefully evaluate the benefits of SMBG for persons with type 2 diabetes. A recent study by Harris[30] reported that nationally, most patients with type 2 diabetes mellitus who take oral agents rarely, if ever, performed SMBG. In Harris' study, frequency of testing was unrelated to glycemic control.[30] However, Karter and colleagues[31] have reported that more-frequent SMBG may have beneficial impact on overall glycemic control. The present study was not designed to be a rigorous prospective trial—it was retrospective and focused on the change in strip use—and medications were adjusted and added by the providers caring for the patients.

Some limitations to our data should be noted. First, we cannot exclude the possibility that patients may be obtaining SMBG strips on their own, as these products are available without prescription. However, it is unlikely a patient would choose to do so because the strips are expensive, and the VA provides them either at no cost or for a nominal $2 monthly copay. Second, we are inferring testing frequency from strip prescription filling patterns. Patients may possibly be filling prescriptions but not testing as frequently as prescribed. However, we think this error is relatively small because all patients visit nurse or pharmacist diabetic educators to check compliance, verify testing technique, and perform quality controls on the meters. This periodic reinforcement of strip technique may serve to maximize the apparent effectiveness of SMBG, and may yield a level of control similar to a population that tests at a higher frequency, but with less well-supervised technique. Visits with diabetes educators typically take place several times a year. Third, a minor change in HbA_{1c} methodology was introduced in the second half of the postimplementation phase with the change of autoanalyzers. The slight decrease in mean HbA_{1c} seen postimplementation in the cohort group, although statistically significant,

was comparable to that seen in our pharmacologically treated population of persons with diabetes overall, and so cannot be attributed to the decrease in strip use. The decrease may also reflect the change in autoanalyzers or other factors, such as intensification of pharmacotherapy for diabetes during this period. However, published data and our application of an empiric correction factor to reconcile the small differences in autoanalyzers suggest that this analyzer effect is clinically negligible.

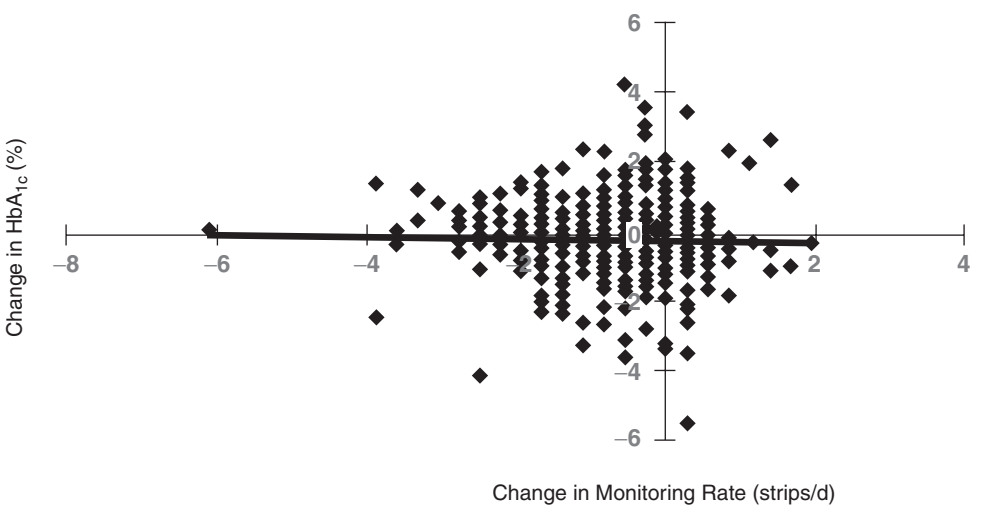
It is possible that intensification of diabetes therapy obscured a minor negative impact of a reduction in strip use. We believe this is unlikely because the natural history of type 2 diabetes is characterized by a gradual worsening of glycemic control over time, with the need to use multiple medications to maintain glycemic stability. Although the number of patients receiving troglitazone in our healthcare system more than doubled during the 2 study periods, only 12% of cohort patients received this agent, half of whom were started after implementation of the policy; most patients were on multiple oral hypoglycemic agents. Furthermore, it is likely that data reported by strip users convinced providers to treat more aggressively, whether or not the strip users were using fewer strips. In fact, we

Figure 3. HbA_{1c} in Study Populations



Data shown as mean ± SD. HbA_{1c} = hemoglobin A_{1c}.

Figure 4. Linear Regression of the Impact of Strip Use Reduction on HbA_{1c}



Data shown are for the medication-treated cohort population. HbA_{1c} = hemoglobin A_{1c}.

did not examine a number of other factors that may affect HbA_{1c}, including drug therapy, diet, body weight, and physical activity level in our population, but assume any influence of these is small based on comparison with the small changes in the nonstudy diabetic population during the same interval.

Finally, the cohort on which we focused our attention represented roughly a third of the total population receiving strips. As such, it could be argued that they may have represented a more adherent or healthier population, and an adverse effect of strip use reduction more apparent in the noncohort individuals might be overlooked. Our data indicate the following: the cohort patients were not overtly different from the other patients in overall clinical characteristics; the cohort patients were not treated more aggressively than the other patients; and the cohort patients did not keep more appointments than the other patients. As such, we think any bias from this "nonignorable" missing data is insignificant.

Both the apparent benefit of SMBG in our patients and the lack of impact of a modest reduction in strip use might reflect highly focused subspecialty care. However, most of our diabetic patients are seen by general internists, with only about one third receiving subspecialty diabetes input.[6,9] It is therefore unlikely that direct subspecialty care contributed in a major way to our findings. It is probable that the observed benefit of SMBG, as well as the stability of HbA_{1c}, reflect a systematic approach to diabetes care emphasizing education and involvement of primary providers in diabetes management. However, it is also likely that other risk factors for poor glycemic control segregate with nonuse of BG strips, and therefore these data are not definitive.

Although the decrease in strip use from 1.36 to 0.74 strip per day may seem small, and somewhat artificial because patients do not use fractional strips, we did report a 45% reduction in strip use in the patients studied. Given that VANCHCS spent almost half a million dollars on testing supplies in 1997, this reduction in strip use potentially represents a large institutional financial benefit. Although some patients were not studied (eg, those on insulin), it is clear that, for certain patients, this strip use policy could be safely implemented.

Our study has design limitations as well. A more rigorous design would have been a randomized study in which individuals were randomized to a no-change group or a decrease in frequency of SMBG testing and then a comparison of HbA_{1c} levels between groups. Although our study was not randomized, we believe that, based on comparisons before and after, our conclusion is valid that a decrease in the frequency of SMBG testing does not result in a deterioration of HbA_{1c} levels.

Pharmacists played an important role in this program, including education not only about SMBG, but also about medication and diabetes in general. In addition, pharmacists, faced with budgetary pressures, identified a cost-savings strategy that was safe, practical, and readily accepted by patients and providers. Van Veldhuizen-Scott and colleagues[32] found that pharmacists' counseling significantly improved patient understanding of diabetes medications, increased patient knowledge about blood glucose monitoring, and made a positive difference in perceptions and attitudes toward diabetes and communication with the pharmacist. Coast-Senior and coworkers[33] determined that pharmacists providing diabetes education, medication counseling, monitoring, and insulin initiation or adjustments had a positive impact on glycemic control in patients with type 2 diabetes requiring insulin. With monthly refills of prescribed medications, pharmacists have the opportunity to interact with patients with diabetes more often than most members of the healthcare team. As numbers of patients with diabetes increase and healthcare dollars become more limited, we must seek opportunities to reduce the cost of diabetes care while maintaining or improving the quality of that care.

This program worked well in a setting of overall stability with patients and providers already educated about the goals of diabetes care. Flexibility is critical to accommodate those who require more intensive monitoring, with both long-term and short-term glycemic goals clearly defined.

In summary, we demonstrated that a multidisciplinary approach to chronic disease management, requiring input and cooperation from providers, nurse educators, and pharmacists, in a suitable patient population, resulted in significant cost savings without compromising patient care. Although we were able to substantially decrease the frequency of SMBG, the ideal frequency of this testing remains to be determined.

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