Clinical Benefit of Self-Monitoring of Blood Glucose Is Uncertain for Non–Insulin-Treated Patients With Type 2 Diabetes

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STUDY

SUMMARY
Design. A comprehensive systematic review and meta-analysis.

Objective. To assess the effect of self-monitoring of blood glucose (SMBG) on A1C in non–insulin-treated patients with type 2 diabetes.

Subjects. The analysis included 3,270 non–insulin-treated patients with type 2 diabetes in Canada, the United States, Europe, and Asia. In the 15 studies included, mean age ranged from 50 to 67 years, with 38–74% female patients. Mean duration of diabetes ranged from 0 to 12.5 years. Mean BMI ranged from 27.1 to 34.2 kg/m², and baseline A1C ranged from 6.7 to 11.9%.

Methods. Studies included randomized, controlled trials of non–insulin-treated type 2 diabetic patients comparing treatment strategies including SMBG to less frequent or no SMBG. To be included, trials also had to report data on A1C. Two independent reviewers assessed study quality, with any discrepancies resolved by a third reviewer. The authors used heterogeneity statistics ($I^2$) to determine the appropriate model for analysis, with high heterogeneity ($I^2 > 80\%$) indicating that no pooled analysis should be done. The primary endpoint was A1C, and secondary outcomes were fasting glucose and the occurrence of hypoglycemia.

The primary analysis was comparing patients performing SMBG with a non-SMBG control group. Secondarily, the authors compared more frequent SMBG with less frequent SMBG. Univariate meta-regression was used to assess the influence of other factors on the main outcomes of interest. Variables examined in the meta-regression included self-management instruction, use of a treatment algorithm, industry sponsorship, country of study origin, baseline mean A1C, study duration, and key domains of internal validity (intention to treat, allocation concealment, blinding of outcome assessors).

Results. Of the 15 studies that met inclusion criteria and were included in the final analysis, 12 trials of 2,934 patients contributed to the primary analysis comparing SMBG to no SMBG. The frequency of SMBG examined varied widely but involved at least six tests per week. This comparison showed that SMBG was associated with lower A1C levels (weighted mean difference $-0.31\%$, 95% confidence interval [CI] $-0.44$ to $-0.17$, $I^2 = 33.3\%$).

The stratified analysis for SMBG versus no SMBG showed modestly larger improvement in A1C with SMBG in non-industry-sponsored trials ($-0.51$ vs. $-0.3\%$), trials performed in the United States or Canada ($-0.8$ vs. $-0.27\%$), trials with a mean baseline A1C $\geq 8\%$ ($-0.38$ vs. $-0.21\%$), those that did not have intention-to-treat analyses ($-0.49$ vs. $-0.23\%$), those without adequate allocation concealment ($-0.44$ vs. $0.2\%$), and those whose assessors were not blinded ($-0.37$ vs. $-0.19\%$). The effect of SMBG was unaffected by study follow-up, education aimed at self-management, or the use of treatment algorithms.

Four trials that included 637 patients contributed to the secondary analysis comparing more frequent SMBG with less intensive SMBG. Overall, more frequent SMBG did not result in significantly lower A1C levels (WMD $-0.21\%$, 95% CI $-0.57$ to $+0.15$), with two trials showing moderate to large effects (change in A1C $-0.4$ and $-0.84\%$) and two showing no benefit ($-0.03$ and $+0.20\%$). Both studies showing benefit compared individualized SMBG regimens with additional education or monitoring; one trial that showed no benefit compared fixed intervals (once daily, twice a week and twice daily, once a week vs. once a week testing).

Conclusion. SMBG was associated with a statistically significant but clinically modest reduction in A1C when compared to no SMBG.
However, more frequent SMBG compared to less frequent SMBG did not improve A1C in patients with type 2 diabetes who were not being treated with insulin.

**COMMENTARY**

Glycemic control is essential to reducing microvascular complications that arise from uncontrolled diabetes. However, the utility of SMBG in contributing to improved glycemic control has not been well proven in patients with type 2 diabetes who are not using insulin.

This question is particularly relevant because of the rising prevalence of type 2 diabetes in the United States and the tremendous economic burden it carries in both direct and indirect medical costs. It has been estimated that the cost of SMBG in the United States is $500 million per year.

Many studies have been undertaken to investigate whether SMBG improves glycemic control. However, these studies have differed in trial design, methodology, and results. Meta-analyses that have attempted to combine these results have generally shown beneficial effect of SMBG with reductions in A1C ranging from -0.16 to -0.4% depending on the follow-up. Previous meta-analyses assessing this subject are difficult to rely on because of the heterogeneity among studies included, resulting from differences in the type of monitoring used, the frequency of the monitoring, and duration of follow-up. One strength of this meta-analysis is that comparisons of SMBG with no SMBG and comparisons of more frequent with less intensive SMBG were separated, thereby reducing overall heterogeneity and allowing for a more accurate assessment of the SMBG versus non-SMBG comparison.

The meta-analysis supports the benefits of SMBG in patients with type 2 diabetes that is not treated with insulin by showing an average A1C reduction of 0.31% in those patients who performed SMBG. Despite these results, we must consider the clinical significance of this reduction, its cost-effectiveness, the impact of the intervention on patients’ quality of life, and the possible psychological effects.

Cost-effectiveness and self-care considerations are crucial considerations when assessing any intervention, but particularly so in disease states associated with significant medical expenditures. Costs per life-year gained have ranged from $8,000 to $39,000, with the higher amount being determined from a hypothetical A1C reduction of 0.39% and the lower amount being per quality-adjusted life-year gained projected from actual patient data showing a 0.32–1% reduction.

It is important to note that these cost analyses do not take into account the time it takes for patients to perform SMBG, which can be significant. If a time of 3 minutes is allotted for each SMBG test, a patient testing six times per week would spend >15 hours annually on SMBG.

Results of the stratified analysis shown here demonstrate that comparable effects were seen whether SMBG was complemented by education or not. This education is defined as instruction on self-management in case of undesirably high glucose values. However, it is not reported whether that education included adjusting lifestyle (e.g., diet and exercise) or medications. SMBG readings can serve as immediate feedback to patients to reflect the impact of dietary, exercise, or health changes on glucose control.

Another important outcome to measure with this controversy is the impact of the intervention on psychological indices. This was not addressed by the present analysis.

However, it has been investigated in at least one randomized, controlled trial. That trial found that newly diagnosed patients who were randomized to the SMBG group had more depressive symptoms, indicated by a 6% higher score on a 12-question depression subscale of a well-being questionnaire. One survey conducted by Franciosi et al. showed that SMBG was associated not only with a higher A1C, but also with a higher psychological burden.

This is a concerning outcome because there is a known link between chronic disease diagnoses and depression. However, improvements in not only glucose control, but also outlook on life, have been seen when SMBG is coupled with structured counseling, although this is not supported by the current meta-analysis.

In summary, SMBG improves A1C compared with no SMBG, but the overall net benefit and cost-effectiveness of SMBG in non–insulin-treated patients with type 2 diabetes remains controversial. Furthermore, more frequent SMBG in patients with type 2 diabetes who are not using insulin is not necessarily better than less frequent monitoring, although this point requires further research.

The American Diabetes Association recommends that for patients who are on non-insulin therapies, SMBG may be useful as a guide to the success of therapy and that care for such patients should include initial instruction on SMBG technique and education on using the data to adjust diet, exercise, or therapy to achieve their goals. In our opinion, SMBG at a modest frequency (2–3 times per week) in non–insulin-treated patients with type 2 diabetes may help patients correlate their lifestyle to glucose control if they are educated on interpreting the results and are willing to
make lifestyle or therapeutic modifications. SMBG does not appear to be a therapeutic intervention in itself, but rather is one part of a comprehensive treatment plan.

REFERENCES


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