

Self-Monitoring of Blood Glucose Using Glucose Meters in the Management of Type 2 Diabetes

Reviewed by the Professional Practice Committee

Self-monitoring of blood glucose (SMBG) is a critical component of diabetes management. SMBG, when combined with appropriate supplies, proper technique and education, provides individuals with the resources and information needed to make decisions regarding medication adjustments as well as lifestyle changes. Diabetes care & education specialists play a key role in assisting individuals with choosing a glucose meter that is appropriate for their needs and covered by insurance. Additionally, ensuring that individuals are using optimal technique can help improve the accuracy of results. Frequent monitoring, interpretation and application of SMBG values can help improve overall glycemic outcomes. The purpose of this paper is to provide basic SMBG guidelines and groundwork so that future papers can focus on more advanced content.

Effective management of type 2 diabetes is contingent on numerous factors and behaviors. Among the AADE7 Self-Care Behaviors™, SMBG can be a key component of the treatment regimen.¹ Large clinical trials have demonstrated that glycemic management, as assessed by hemoglobin A1C (A1C), reduces the microvascular changes that lead to severe diabetes-related complications.²⁻⁴ The reduction seen with microvascular, as well as macrovascular, complications was confirmed with the long-term follow-up of the UKPDS trial.⁵ Current evidence also suggests that post-prandial hyperglycemia can be a risk factor for the development of both microvascular and macrovascular disease leading to cardiovascular risk.⁶⁻⁸ Individualized approaches to lowering the risk of complications are especially important for the adult with type 2 diabetes.⁹

Although the self-monitoring market may be dominated by the trend towards continuous glucose monitoring, with more funding and research in that area, SMBG continues to be a tool used by many people with diabetes (PWD). In 2015, the CDC

reported that 62% of PWD are self-monitoring their blood glucose at least once a day.¹⁰

SMBG is an important complement to the measurement of A1C levels because it provides the person with immediate feedback about their blood glucose levels. Unlike A1C monitoring, SMBG provides the person with diabetes a means to distinguish fasting, pre-prandial, and postprandial blood glucose levels, allowing them to monitor the immediate effects of food, physical activity, and medications on glycemic management.¹¹ To be useful, SMBG must be integrated into the diabetes self-management plan in a personalized way so that results are meaningful to the individual.¹²⁻¹³ The diabetes care & education specialist has the skills and training required to ensure the person with diabetes understands the targets and techniques of SMBG, and more importantly, understands how to evaluate and use the data to improve blood glucose levels.

The role of the diabetes care & education specialist is to:

- Complete a full assessment and work with the PWD to choose the appropriate device for SMBG
- Work with the PWD to understand how to use the glucose meter
- Determine the timing of SMBG
- Interpret the results
- Create a plan to enhance diabetes self-management based on findings

Background

SMBG refers both to the act of checking blood glucose levels with a blood glucose meter and utilizing the results to make lifestyle and treatment regimen decisions. Results need to be used by the PWD to make necessary changes to self-care behaviors, to collaborate with their healthcare provider on a routine basis for feedback, and to analyze data and identify potential action plans. Unfortunately, some people with diabetes may not understand how to utilize SMBG results in the above-described ways. Thus, there is a need to remedy this through diabetes self-management education and support.

While the benefits of SMBG have been demonstrated in persons with type 1 diabetes and persons with type 2 diabetes who are treated with insulin, outcomes of studies assessing the effects of SMBG in persons with type 2 diabetes who are not treated with insulin have revealed inconsistent results. A Cochrane review of randomized controlled trials published in 2012 concluded that there was no substantial evidence of a beneficial effect of SMBG in people with type 2 diabetes not treated with insulin.¹⁴ A subsequent review published in 2013 criticized the Cochrane review for excluding many studies and drawing conclusions from only a small number of studies; trials reviewed in the 2013 paper associated SMBG with major and significant decreases in A1C in persons with type 2 diabetes not treated with insulin.⁷ These inconsistent findings may be due to differing study design elements or other factors, e.g., the implementation of intensive treatment in both the SMBG and control groups.

A limitation of some trials included in the Cochrane review analysis¹⁴ was the lack of information on modification of behavior or treatment in response to the blood glucose level readings.^{6-7,15} In a study

published 2017 in JAMA, data supports that in subjects with non-insulin-treated type 2 diabetes there was no observed clinically or statistically significant differences in glycemic management or health related quality of life between subjects who performed SMBG compared with those who did not perform SMBG after 1 year.¹⁶ In contrast, a consensus report found that high quality efficacy data from randomized controlled trials which used a structured approach (a defined monitoring regimen where results were used to make pharmaceutical or lifestyle adjustments) demonstrated efficacy of SMBG in non-insulin treated type 2 diabetes.¹² Similarly, in the Structured Testing Program study (N=483), appropriate use of structured SMBG significantly improved glycemic management and facilitated more timely/aggressive treatment changes in non-insulin treated type 2 diabetes without decreasing general well-being.

Beyond improving clinical outcomes, SMBG data can improve quality of life.¹⁶ Most people with diabetes believe that using SMBG has beneficial health outcomes, and those who received training in the interpretation of SMBG results experienced fewer negative feelings about SMBG compared to those who relied on providers to interpret their results.¹⁷⁻¹⁸

Interpretation of the blood glucose data

People with type 2 diabetes with proper training are able to use SMBG to predict future episodes of hypoglycemia.¹⁹ People with diabetes who inject insulin can be shown how to titrate their insulin dosage based on SMBG values to achieve improved glycemic management while minimizing acute episodes of hypoglycemia.²⁰ Young children or their parents and adults may not recognize symptoms of hypoglycemia with hypoglycemia unawareness. SMBG is particularly valuable in these populations.²¹ Currently, there are no guidelines or standards for blood glucose monitoring in the growing type 2 pediatric population. In an article by Copeland²² the author recommended that monitoring be done fasting and post prandial at a minimum. This is an indication that more research is needed in this area.

SMBG also has an important place in the management of diabetes in pregnant women, i.e., gestational diabetes. The American Diabetes Association recommends SMBG fasting and after meals and, in some women, before meals to monitor

treatment programs in pregnant women.²³ Similarly, the National Institute for Health and Clinical Excellence clinical guidelines advise pregnant women with pre-existing diabetes to check fasting and one-hour post-prandial blood glucose levels after every meal during pregnancy.

Summary:

The Diabetes care & education specialist must:

1. Teach and assess meter and monitor technique. Accuracy of SMBG results are meter- and user-dependent. The diabetes care & education specialist must periodically assess the accuracy and appropriateness of the blood glucose meter being used, as well as the technique of the user. The accuracy of these instruments is affected by individual and environmental variables, including hematocrit, hypotension, hypoxia, hypertriglyceridemia, concomitant drugs, as well as temperature, humidity and altitude.²⁴ The diabetes care & education specialist can assist in selecting meters that will be accurate under the conditions they will be used.
2. Be familiar with published data related to the accuracy of current meters, which can help with shared decision making around meter selection for PWD.
3. Be advocates for the individual to insurance companies and suppliers with regards to access to the appropriate monitor based on their individual needs.
4. Help determine the optimal frequency of blood glucose monitoring based on medication regimen, level of glycemic management, and the individual's specific needs and goals.²⁴ These are based on guidelines from ADA, AACE, and ADCES. Diabetes care & education specialists also inform people with diabetes about what to do regarding SMBG in special situations such as illness, periods of stress or trauma, and initiation of new medications that can affect blood glucose levels.²⁵
5. Help interpret results and recommend action. If SMBG is simply prescribed without education, people with diabetes are less likely to take advantage of the feedback that SMBG provides about their immediate response to medication, lifestyle behaviors, stress and illness. Clinical trials have demonstrated that those trained in using SMBG were more likely to follow instructions regarding meal planning, because they observed the immediate effects of their food intake on blood glucose levels.¹⁶ Diabetes care & education specialists are skilled at guiding PWD in how to interpret their SMBG results and make appropriate adjustments to their medication, diet, and physical activity.²⁵ Diabetes care & education specialists are able to help people with diabetes optimize use of SMBG by teaching pattern management and problem solving skills while reviewing high or low blood glucose results with the individual.²⁶ In order for SMBG to be most meaningful to individuals, they must be familiarized with the target goals for blood glucose levels throughout the day in relation to meals and snacks, in addition to knowing their target A1C. The diabetes care & education specialist must compare blood glucose records with the A1C to identify possible causes if the results are in conflict.²⁷⁻²⁸
6. Identify and address barriers to SMBG which can include cost; pain; inconvenience; forgetfulness/distraction; poor understanding of SMBG usefulness; disappointment in the results; psychosocial factors such as emotional distress, lack of family support or low self-esteem; language, limited literacy and numeracy skills; and physical or cognitive issues.²⁹⁻³⁰ All of these barriers will need to be addressed by the diabetes care & education specialist. This may involve the use of validated tools for screening for these factors as well as the use of referrals for any support necessary for the success of diabetes education cognition. This support may be necessary for those affected by and caring for the person with diabetes as well. The issues around pain and inconvenience may be larger in the person's perception than in reality.³¹ People with

diabetes whose SMBG supplies are covered by insurance were found to have lower A1C levels than those without insurance coverage.³² Individuals with diabetes whose support persons were depressed, had low self-esteem, or low levels of optimism, were less likely to perform SMBG.³³

7. Recommend mechanisms for communication and ongoing support. The diabetes care & education specialist must evaluate an individual's primary support network and, provide additional support and encouragement.³⁴
8. Facilitate communications between PWD and their healthcare provider(s) to ensure the SMBG results are shared and discussed.

ADCES recommends the following practices:

- SMBG readings are to be used in clinical decision-making by every member of the individual's healthcare team.

- Diabetes self-management education and support must include instruction on recognizing blood glucose levels that are out of the target range and taking the appropriate action steps in response to such readings.
- In appropriate cases where barriers such as cognitive limitations impede effective use of SMBG, diabetes care & education specialists and people with type 2 diabetes need to individualize regular performance of SMBG, based on the person's needs and abilities.

Self-monitoring of blood glucose is an important aspect of diabetes self-management. The diabetes care & education specialist must be an integral member of the diabetes team in selecting the appropriate glucose meter, educating the individual on the use of the meter, the contribution of the results of checking, to diabetes self-management and the interpretation and application of the data, to changes in the diabetes care plan.

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Resources

ADCES provides additional resources in the practice section of www.diabeteseducator.org

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