Review Article

Self-monitoring blood glucose method and outcome: A review

Abstract:

Self-monitoring of blood glucose (SMBG) is a valuable technique for diabetes mellitus treatment. Patients with diabetes frequently monitor their blood glucose levels in order to identify hypoglycemia and modify their insulin dosage as necessary. In many large-scale outcome studies, self-monitoring of blood glucose (SMBG) in the management of diabetes plays a vital role, contributing significantly to the outcomes. It is recommended that the patient keep track of their SMBG readings in a log book. For interpreting the SMBG findings, information regarding food intake, medication, and activity may be useful. An explanation of the practical components of the process is required to assess a patient's grasp of SMBG knowledge. For SMBG lancing treatments to be effective, the patient must have a thorough understanding of the stages involved. With many studies suggesting the benefits of SMBG other studies say that SMBG has little clinical effectiveness in improving glycemic control in patients with T2DM who are taking oral medications or eating a low-carbohydrate diet alone, and is thus unlikely to be cost-effective. However, if patients have the ability to modify their treatment dosage then it can be much more effective. In this review we will be looking at the SMBG techniques, outcomes and the relationship with glucose management.

Introduction:

Self-monitoring of blood glucose (SMBG) is a valuable technique for diabetes mellitus treatment. Patients with diabetes frequently monitor their blood glucose levels in order to identify hypoglycemia and modify their insulin dosage as necessary. Others use SMBG to create a profile of blood glucose levels and how they respond to diet and medication. The American Diabetes Association created

the first SMBG guidelines, and current recommendations encourage frequent SMBG in diabetic patients based on their individual needs. SMBG records can also be used to titrate blood glucose-lowering medications and advise physical activity and food consumption during consultations with diabetic health care professionals. [1]

In many large-scale outcome studies, self-monitoring of blood glucose (SMBG) in the management of diabetes plays a vital role, contributing significantly to the outcomes. SMBG offers a number of well-established advantages, including assisting in the accomplishment of haemoglobin A1c (HbA1c) goals, reducing glucose variability, and aiding in the prediction of severe hypoglycemia. SMBG has also been linked to lower diabetes-related morbidity and all-cause mortality in type 2 diabetes, according to an epidemiological cohort research. Patients' knowledge of the illness and the influence of lifestyle on blood glucose levels can also be increased using SMBG. [2-9]

For people with type 2 diabetes mellitus (T2DM) who do not use insulin, there is dispute about the best frequency and timing of SMBG. Some health professionals are sceptical of SMBG's efficacy as a self-management tool. Regular SMBG, on the other hand, predicts hospitalisation due to diabetes-related complications. Blood glucose self-monitoring has also been found to lower haemoglobin A1c levels (A1C). The American Diabetes Association (ADA) suggests utilising SMBG as a guide to effective medication and achieving postprandial glucose goals. [1,10-12]

The National Health Service of the United Kingdom paid £158 million for blood glucose self-monitoring in 2011, accounting for 21% of diabetes prescription expenses. According to the Centers for Disease Control and Prevention, 63.4 percent of diabetic patients in the United States use SMBG on a daily basis, and the Diabetes Glycemic Education and Monitoring trial found that the 12-month costs of SMBG were similar in both the less intensive (£92) and more intensive (£84) SMBG groups. SMBG has been shown to be helpful in the treatment of type 1 diabetes. However, there is no agreement on the efficacy of SMBG for self-management of non-insulin-treated type 2 diabetic patients. [13]

Despite mounting evidence that SMBG is an important component of self-management, many individuals who are advised to test often do not test as frequently as they should, and many do not test at all. Individual SMBG practise

varies greatly in terms of frequency, timing, measurement itself, interpretation of data, actions done as a result, and evaluation of the outcome. Clinical advantages reported in experimental research that require SMBG to be performed according to precise protocols are frequently not repeated in observational studies, which may be due to these large differences in practise. [14]

Goals of self-monitoring and glucose levels:

A1C should be less than 7%, which corresponds to a blood glucose level of around 150 mg/dl. The American Diabetes Association advises that preprandial plasma glucose levels be between 70 and 130 mg/dl, with peak postprandial levels at 180 mg/dl. When a person with diabetes uses SMBG, it can help them create a longitudinal glucose profile and make day-to-day decisions. A fasting plasma glucose of 100 to 125 mg/dl or a 2-hour postprandial glucose of 140 to 199 mg/dl, as well as an A1C score of 5.7 percent to 6.4 percent, are associated with an elevated risk of diabetes, according to the 2010 Standards of Medical Care in Diabetes. Furthermore, provided the test is done by a laboratory using a validated technique, the updated guidelines allow the use of an A1C of more than 6.5 percent as a possibility for diabetes diagnosis. [1]

Because severe hypoglycemia frequently follows a certain blood glucose fluctuation pattern that can be identified by SMBG, it is feasible to make a partial forecast of incoming severe hypoglycemia, which can aid in the self-regulation of substantial hypoglycemia. To assist diagnose hypoglycemia in individuals with T2D who take oral glucose lowering medications and/or combination therapies, expert organisations advocate the use of SMBG. Although the risk of a first episode of severe hypoglycemia was higher with insulin glargine than with standard care in ORIGIN (1.00 vs 0.31 per 100 person-years), the absolute increase in risk was small (approximately 0.7 more severe episodes and 11 more suspected or confirmed episodes per 100 person-years) compared to other insulin studies. [2,15,16]

It is recommended that the patient keep track of their SMBG readings in a log book. For interpreting the SMBG findings, information regarding food intake, medication, and activity may be useful. Keeping a journal will also assist the patient to recognise their SMBG and consider what changes they might be able to make in terms of exercise and diet. For the health team to modify medicine,

manage problems, and propose lifestyle (activity, stress, diet) adjustments for the patient, accurate data is critical. [1]

The rate of significant hypoglycemia episodes per year in the United Kingdom Prospective Diabetes Study (UKPDS) was 1.8 percent vs 0.7 percent with insulin and traditional therapy, respectively, an absolute risk difference of 1.1 percent. The Action to Control Cardiovascular Risk in Diabetes (ACCORD) trial and the Veterans Affairs Diabetes Trial are two such studies in which patients getting intensive therapy reported greater incidence of severe hypoglycemia than those receiving conventional care . In ACCORD, the annualised rate of hypoglycemia needing medical attention was 3.1 percent vs 1.0 percent, resulting in a 2.1 percent absolute risk difference. In VADT, there was a 2.0 percent absolute risk difference in the yearly rate of severe hypoglycemia (3.8 percent vs 1.8 percent, respectively). [2,17-19]

Self-Monitoring of Blood Glucose Methods:

To ensure reliable data from SMBG, many steps are required. An explanation of the practical components of the process is required to assess a patient's grasp of SMBG knowledge. For SMBG lancing treatments to be effective, the patient must have a thorough understanding of the stages involved. The majority of SMBG metres come with a lancing device. It will be critical for the patient to show how to adjust the lancing device's depth to minimise bruising while obtaining a sufficient blood sample. Many metres allow you to use additional locations besides your finger, however getting a blood sample without instructions might be difficult. Lancing tools with several lancets placed into a system that rotates a cylinder provides an alternative to handling individual sharps. This is lancing procedure steps: [1,20-22]

- Clean the area with warm, soapy water and then dry it. Food residue might cause inaccurately elevated blood sugar levels.
- Lancet blood collection devices come in a variety of shapes and sizes, but they all puncture the skin with a lancet. Lancets that are thin and pointy are more comfortable. Lancets should not be reused or cleaned since they get dull rapidly.

- The lancet device's depth setting governs the stick's penetration and may be adjusted for maximum comfort and blood sample size. The majority of metres only require extremely tiny samples—less than a droplet.
- The lancet should be placed firmly but not forcefully to a clean, dry finger.
- Because the sides of the finger are less painful, they should be utilised. It may be better to use the third, fourth, and fifth digits rather than the index and thumb.
- For several metres, alternate test locations (upper arms and thighs) have been allowed. Fingertips or the outside palm of the hand are preferable since they are more precise.
- A gentle "milking" from the base of the finger to the lanced tip should be used to get a blood sample. It is not advisable to apply pressure directly to the lancing site.
- Sharps disposal for lancets and SMBG testing supplies should be done in accordance with local regulations. A hard-plastic container with a screw lid can be thrown away in the garbage in many places.

- In both gestational diabetes mellitus and preexisting diabetes in pregnancy, fasting and postprandial self-monitoring of blood glucose are suggested to attain optimum glucose levels. Fasting plasma glucose should be less than 95 mg/dL (5.3 mmol/L), and 1-h postprandial glucose should be less than 140 mg/dL (7.8 mmol/L) or 2-h postprandial glucose should be less than 120 mg/dL (6.7 mmol/L). Preliminary blood glucose testing is also recommended for certain women who have diabetes. [23]
- A1C is somewhat lower in normal pregnancy than in normal nonpregnant women due to enhanced red blood cell turnover. If severe hypoglycemia is avoided, the A1C target in pregnancy should be 6% (42 mmol/mol), but if this is not possible, the aim should be lowered to 7% (53 mmol/mol) to avoid hypoglycemia. [23]

Hospitalized Patient:

If patients are competent to operate their diabetic equipment, such as insulin pumps and sensors, they should be given the opportunity to do so in an inpatient environment. Patients who are experienced with treating their own blood sugar levels are generally better at adjusting insulin dosages than inpatient personnel who are unfamiliar with the patient or their management approach. However,

this should be done in accordance with the hospital's diabetes management policies, and there should be supervision to ensure that the individual can adjust their insulin doses while hospitalised, where factors such as infection, certain medications, immobility, dietary changes, and other factors can affect insulin sensitivity and insulin response. [24]

The FDA has approved the use of CGM in hospitals for patient monitoring in the wake of the coronavirus illness pandemic of 2019. This method has been used to decrease the usage of personal protective equipment and to better monitor patients, so that medical staff do not have to enter a patient's room only to take a glucose reading. Studies are being conducted to determine the efficacy of this method, which might lead to the widespread use of CGM for monitoring hospitalised patients in the future. [24]

Role of Self-monitoring and glucose management:

Regular customised SMBG is generally recommended as an important tool for the optimum treatment of all patients with type 1 diabetes, according to clinical practise recommendations. The fundamental logic is based on numerous considerations, including patient safety (hypoglycemia detection and prevention), efficacy (increased insulin effectiveness through dosage modification), and flexibility (e.g., regarding dietary choices and physical activity). In patients with type 1 diabetes, the recommendations indicate that SMBG be done at least three times per day, and that it should include both fasting and postprandial glucose readings. [25-30]

In a large-scale study that looked at Hyperglycemia and Its Effect After Acute Myocardial Infarction on Cardiovascular Outcomes in Patients With Type 2 Diabetes Mellitus (HEART2D) experiment, which included 1115 T2D patients with recent acute myocardial infarction, it used SMBG. The goal of this study was to see how CV outcomes were affected by prandial versus basal strategies. Participants were randomly allocated to one of two treatment groups (prandial or basal approach) with the goal of achieving a HbA1c level of less than 7.0 percent. Furthermore, those in the prandial treatment group (mealtime insulin lispro 3 times daily) had a self-monitored postprandial glucose (PPG) target of less than 135 mg/dl, whereas those in the basal group (neutral protamine hagedorn twice daily or insulin glargine once daily) had an

FBG aim of less than 121 mg/dl. When HbA1c readings were above 8.0 percent on two consecutive visits, treatment dosages were changed correspondingly, and patients were monitored for up to seven years. After about three years, the experiment was terminated due to a lack of effectiveness, since no change in the risk of future CV events was detected between the two groups. Despite substantial variations in PPG and glucose excursions between the two groups, no changes in CV outcomes were detected. This might be due to the lower FBG levels attained in the basal group compared to the prandial group (7.0 vs. 8.1 mmol/l). Furthermore, the difference in PPG levels did not exceed the 2.5 mmol/l target used in the power calculations to fulfil the primary aim. Without a doubt, SMBG played an important role in the trial, helping to keep HbA1c levels equal between the two groups. [2]

Other constructs that have implications for diabetic self-care in general have been discovered in several qualitative research. Levels of engagement, resistance to a diabetic identity, varying degrees of personal responsibility, and the difficulties of trying to live a "normal" life are among them. it is demonstrated that patients have an impact on whether and how SMBG is carried out. Self-management techniques may evolve and change over time. There have been demands for educational interventions to increase awareness and comprehension of SMBG and how to implement it practically. There have also been demands for educational interventions in the area of outcomes interpretation. Others have realised the significance of motivating and changing one's behavior. However, it's considerable that the challenges to successful SMBG may be even deeper. Individuals' diabetes-related attitudes and beliefs (internal structures) have a direct impact on SMBG practises and related reactions. [14]

The Treat to Target with Once-Daily Insulin Therapy: Reduce A1C by Titrating Effectively (TITRATE) research was another one in which patients had a big say in how SMBG treated them. TITRATE was the first prospective randomised trial to use patient-directed titration of once-daily insulin detemir to investigate the effect of varied FPG goals on glycemic management. The study's goal was to assess the effectiveness and safety of two FPG titration goals (80-110 mg/dl and 70-90 mg/dl) in insulin-naive patients with T2D who weren't getting enough alleviation on oral antidiabetics. Subjects self-titrated their insulin

detemir dosage every 3 days based on the mean FPG level of daily measurements collected in the preceding 3 days using a patient-directed, treat-to-target algorithm. Patients were also given a patient card (to aid with calculations and dosage), a patient training booklet, education and counselling sessions, office visits, and frequent phone contact. [2]

According to the data, SMBG has little clinical effectiveness in improving glycemic control in patients with T2DM who are taking oral medications or eating a low-carbohydrate diet alone, and is thus unlikely to be cost-effective. Only in the context of adequate education - both for patients and health-care providers - on how to respond to the data in terms of lifestyle and treatment change may SMBG lead to improved glycemic control. Furthermore, SMBG may be more successful if patients are able to alter their medication therapy on their own. [31]

Given the high costs of SMBG, if the technology is shown to be unsuccessful in the treatment of individuals with T2D who do not require insulin, the investment will be wasted. In contrast, if SMBG is proved to be successful, approximately 200 million T2D patients in low- and middle-income nations may be encouraged to use SMBG as a relatively low-cost health technology to treat their illness. SMBG was found to be helpful in lowering glycated hemoglobin (HbA1c) levels in T2D patients in many meta-analyses. Others reported that the SMBG group did not outperform the control group by a considerable margin, but that the duration of follow-up differed. The most recent meta-analysis was a Cochrane review published in 2012, which found that SMBG had a minor effect on glucose control at 6 months, but that the effect faded after 12 months, indicating that the clinical benefit was limited. [13]

Conclusion:

Self-monitoring of blood glucose (SMBG) is a valuable technique for diabetes mellitus treatment. Many studies suggest that SMBG is vital in management of DM and it contributes significantly to the outcomes. Others question the cost-effectiveness of the test because it has no significant results when it comes to clinical outcomes as patients don’t have much of a say when it comes to

treatment options and dosage, however it's still vital method for education of the patient and make sure he is more committed and aware of his treatment

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