Self-monitoring of blood glucose: psychological barriers and benefits

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Introduction

Although self-monitoring of blood glucose (SMBG) is recognised as an essential part of diabetes self-management, at least for insulin-requiring patients, the uptake of SMBG is generally poor. Most patients do not test their blood glucose (BG) at the recommended frequency: on average, people with type 1 diabetes only test their BG twice a day and a substantial minority of patients report that they seldom or never test, although others test extremely frequently, to avoid hypoglycaemia and reduce anxiety.[1–3]

Even when patients perform regular tests, SMBG does not automatically produce satisfactory glycaemic control. Patients need to correctly interpret the glucose readings that they

Summary

Diabetes is to a large extent a self-managed disease and, in this context, self-monitoring of blood glucose (SMBG) is essential, at least for insulin-treated patients. In practice, the uptake of SMBG is generally low: many patients fail to self-regulate their treatment appropriately. By contrast, a minority of diabetes patients very frequently self-test their blood glucose levels each day to achieve strict glycaemic control. These differences in usage of self-monitoring are largely explained by psychological and social factors. We present a 5-step biopsychosocial model of SMBG – from decision to test (or not), to evaluation of outcomes – that may help to identify and address perceived barriers and benefits from the patient's perspective. Understanding the fundamental psychological principles that underlie SMBG behaviour is a prerequisite to the effective education and counselling of patients who experience problems with SMBG. New technologies are likely to increase the precision of measurement and patient convenience, but not the fundamental challenge of managing negative feedback as part of self-regulating behaviour.

Eur Diabetes Nursing 2008; 5(3): 112–115

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obtain, then take appropriate action and evaluate outcomes if necessary. What are the barriers to optimal use of SMBG and what benefits do patients see? Will new technological developments change patients' self-management behaviour? These are important questions that we seek to answer in this short review, which focuses on the psychological implications of SMBG (presenting a five-step model), highlights specific barriers and possible solutions, and discusses new developments.

A biopsychological model

The introduction of home glucose monitoring in the 1980s caused the responsibility for daily diabetes treatment to shift from doctor to patient. Today, diabetes education builds on the premise that self-management is the cornerstone of overall diabetes management, of which self-monitoring is an integral part, at least for insulin-treated patients.[4]

Technological developments have enabled better and more convenient self-testing devices to become available. However, this advancement appears not to have changed patient behaviour significantly, primarily because of psychological factors.[5]

To improve our understanding of SMBG behaviour and its psychosocial consequences, we have developed a biopsychosocial model (Figure 1). The model identifies five steps in the process. At each phase, emotional and behavioural factors that impact on the next step can be identified. The patients' emotional and cognitive appraisal of SMBG will, to a large extent, determine future self-testing behaviour.

Step 1 involves deciding whether or not to perform a test. This choice may be based on routine (e.g. time of day, pre-meal) and/or precipitated by 'internal' cues such as sweating, fatigue or experiencing difficulty in concentrating, any of which can urge

the patient to check for a falling or rising BG level. Patients who find that their BG readings are always in line with their expectations, may feel reassured that they have accurate symptom awareness and therefore see no need to test frequently. Some may want to check the concordance between their estimated BG levels and real values intermittently, to reassure themselves that they are symptom aware and that frequent testing is unnecessary. Conversely, when BG readings are out of range without producing symptoms, this may prompt the patient to check levels more frequently, particularly in 'risky' situations. The decision not to test may be related to a variety of reasons, such as fear of the self-testing process or anticipation of negative social reactions to SMBG, if testing needs to be undertaken at work or in public. A patient may be motivated to test but not able to, due to situational factors. In most cases self-testing is feasible, at least within a few minutes, but this requires the patient to interrupt his/her activities and explain the need to check their BG levels to others who are present.

However, the decision whether (or not) to test is not merely driven by internal cues. Patients may be urged to check their BG by their partner or parent (external cues). Obviously patients can choose not to follow such advice, which can cause relationship conflicts. Such conflicts are even more likely if patients repeatedly fail to take action in time to prevent hypoglycaemia.

Patients may report that they intend to self-test BG levels frequently or periodically, but simply forget to do so. Adolescents, in particular, seem prone to forgetfulness, skipping self-tests while engaging in social activities. Anecdotal data suggest that self-monitoring is viewed by many teenagers as being the most inconvenient, disruptive and least favourite aspect of having diabetes.
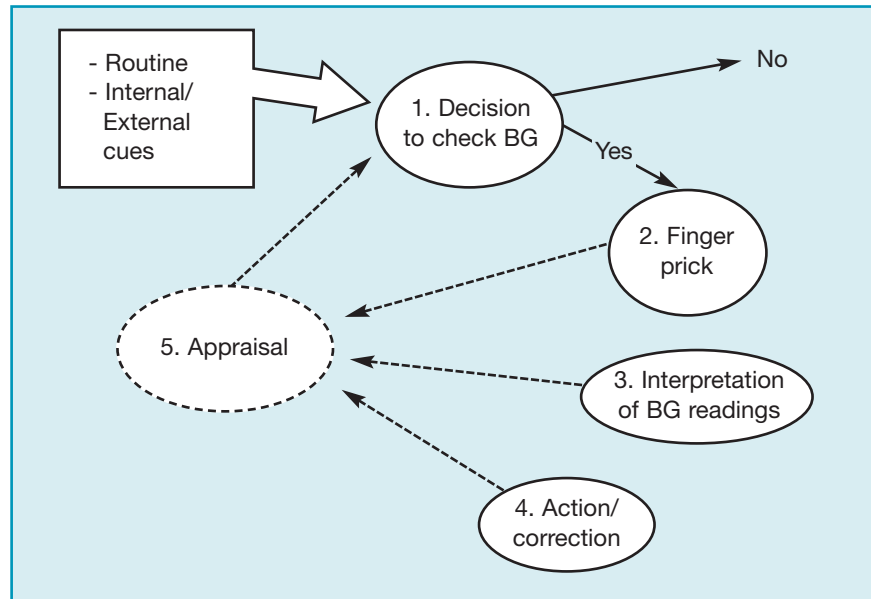

Figure 1. The self-monitoring of blood glucose (BG) process, from decision to appraisal

The (perceived) psychological advantage of not knowing 'your numbers' is obvious, as this implies not having to engage in any subsequent self-regulatory activities – at least in the short term. Of course, not testing (and acting on the test result) may go with a high risk of metabolic dysregulation and its associated psychosocial consequences. Some patients are characterised as having a 'blunting' coping style, i.e. a tendency to avoid confrontation with potentially threatening health information and unfavourable outcomes.[6] In contrast, other patients may be 'monitors', who are very keen on knowing all there is to know about their health state, which may be associated with fear of hypoglycaemia or complications. This may lead them to test their BG very frequently, thereby running the risk of reinforcing their anxiety and becoming more and more dependent on their BG meter.

The *finger prick* (step 2) may be experienced as annoying or neutral ('routine'). Behavioural psychology predicts that negative experiences with SMBG prompt patients to avoid it as much as possible, hence decreasing the likelihood of future testing.

This certainly applies to patients who have a phobia of self-testing, which often coincides with fear of pain.[7]

The *interpretation of BG readings* (step 3) can be a challenge. Understanding the outcomes requires diabetes education and sufficient cognitive ability. Children, adolescents and older patients may test and log their findings in a diary, but may not feel able to make sense of the readings on their own. Online consultation programmes and computer-assisted information management systems can help patients to discover patterns and identify critical factors in managing BG levels.[8] Patients are often faced with unexpected results that can undermine their sense of control. Indeed, much of the burden of SMBG appears to be related to the emotional impact of facing (unexpected) 'poor' test results which, in most cases, mean high BG levels. Frequent negative feedback can easily induce feelings of anger, frustration and hopelessness, particularly in patients who are highly motivated to achieve strict glycaemic control.

The interpretation of BG data also depends on emotional factors.

113

Negative mood can bias the way in which information is processed; information that is congruent with one's negative mood is more easily processed and recalled. Depressed individuals, compared with the non-depressed, tend to evaluate their personal qualities and future expectations more negatively, underestimate their positive qualities and present successes, exhibit more pessimism and interpret feedback more negatively. Consequently, depression promotes misinterpretation of BG readings.[9]

Self-tests may prompt immediate *action*, which is aimed at correcting BG fluctuations (step 4), or checking 1–2 hours later to confirm that the BG level remains within the desired safe range. Having to correct BG values (for example, having to adjust insulin and/or food intake) can be considered a hassle. Data on reported self-management behaviours suggest that most patients seek to minimise daily adjustments, while a minority of patients very frequently adjust insulin, food and/or activity to achieve strict glycaemic control, even to the extent that they exhibit obsessive-compulsive behaviour.

Experiences and outcomes related to SMBG are *appraised* by patients (step 5) as part of the overall psychological self-regulatory process.[10] A positive appraisal reinforces SMBG behaviour, whereas a negative appraisal decreases SMBG frequency. How a patient copes with SMBG outcomes depends on the person's coping style, as well as the support which they obtain from others. Some patients are easily discouraged; others are more resilient and persist in their efforts to self-regulate diabetes in the face of negative outcomes. Particularly depressed and anxious patients who repeatedly fail to control their BG in accordance with their SMBG results are prone to develop 'learned helplessness', a state of emotional exhaustion and apathy that results from prolonged exposure to uncontrollable stress.[11]

Overcoming barriers to SMBG

Problems with SMBG may involve cognitive, emotional, behavioural and/or social factors that often appear not to be addressed in routine clinical care. Recognition of psychological barriers to SMBG will help patients to feel recognised, enabling them to cope more effectively with SMBG as part of diabetes self-management. In this context we need to remind ourselves that SMBG is a means to an end, not a goal in itself, and that patients may reach their individual goals in different ways. Following the model described above, we can identify two key issues that need to be addressed.

Motivation to self-monitor

Providing education on the need for, and benefits of, strict glycaemic control can help patients to develop and strengthen curiosity and intrinsic motivation to self-test, as part of daily self-management. Low frequency of SMBG may be related to the belief that the patient 'knows' when he or she is 'high' or 'low' and therefore does not need to undertake regular testing. Counselling patients on the different purposes of SMBG (beyond preventing hypoglycaemia) can be helpful, particularly when combined with experimentation. Patients can, for example, test their symptom awareness by estimating their BG level, then checking the real BG value, plotting both levels in an error grid analysis (a technique developed from Blood Glucose Awareness Training, [BGAT]).[12] Testing one's symptom recognition accuracy can help to identify specific and sensitive symptoms for hyper- and hypoglycaemia and reinforce the need to check BG levels. Particularly with newly diagnosed patients and after change of therapy, SMBG can help to clarify the effect of exercise and food on BG levels.

An important barrier to (frequent) SMBG is related to the negative beliefs that surround self-testing, in particular the anticipated high emotional 'costs' and/or low outcome expectancies. Respectfully exploring and discussing patients' beliefs and attitudes can contribute to developing more positive SMBG awareness. Here too, experimentation can prove to be helpful in re-shaping SMBG behaviour. Providing patients with patient-friendly tools and behavioural strategies to help them tackle difficult social situations can strengthen self-efficacy beliefs and increase the likelihood of SMBG performance in the face of social barriers. For those who express fear of self testing, the Diabetes Fear of Injecting and Self-testing Questionnaire (D-FISQ) is a helpful tool for determining the level of anxiety and the need for psychotherapy.[13]

Dealing with (poor) SMBG results

It is critical to ensure that a patient has the sufficient cognitive skills required for a good understanding of the numbers and what they represent. Particularly in young children and the elderly, cognitive function and associated problem-solving skills warrant attention. Understanding how variations in BG levels occur often takes some time, especially for patients new to self-monitoring. In patients with non-insulin treated type 2 diabetes, episodic testing, rather than daily routine testing, could prove helpful. Whatever the frequency, physicians and other care team members should show interest in their patients' SMBG results. Unfortunately, physicians apparently often fail to discuss a patient's test results, which is demotivating and a major reason for patients to stop testing.[14]

Diabetes care professionals have an important role in educating and supporting patients in handling 'negative' outcomes. Offering patients a manual to help them take a positive

approach toward test results and avoid interpreting BG values as 'failures' leads to a less negative opinion of SMBG and more frequent testing, both in young patients and adults.[15] Highly anxious patients (and their partners/parents) can have great difficulty staying calm and making appropriate decisions when faced with extreme highs or lows. Overcorrection can easily occur at the expense of glycaemic control, creating confusion and panic. Diabetes professionals should be sensitive to the anxiety that surrounds SMBG results, and offer patients problemsolving and relaxation techniques to enhance coping skills and self-efficacy. In adolescents, most diabetes-related conflicts with parents concern BG testing – or lack thereof – which has a negative effect on family climate and diabetes management. Offering a 'team' approach, addressing the problem of under- and over-involvement of parents in response to poor self-care behaviours in teenagers is important in resolving family conflicts.[16]

New technology?

In view of the psychological issues discussed, we can question how continuous glucose monitoring (CGM) and real-time glucose sensors will impact patients' experience and self-management behaviour. CGM allows for automatic frequent BG data collection but still requires the patient to perform regular finger pricks for calibration purposes, along with logging physical activity and food intake in a diary. Handling the CGM outcomes retrospectively can be as challenging as handling SMBG results, indeed more so, without appropriate educational support. The psychological impact of real-time sensors that provide patients with warning signs when glucose values are out of range is unclear. For some this may provide a safety net, helping patients to avoid severe hypoglycaemia and its adverse effects. However, such sensors may

lead patients to become dependent on external cues, rather than learning to be proactive and prevent extreme fluctuations from occurring. This development would call for educational programmes that cover the use of real-time sensors, with a focus on patient activation and self-efficacy.

Until there is a closed-loop system that automatically regulates insulin dosage in response to changing glucose levels, patients will have to interpret the results and correct when needed. Current technology can offer more precision and better protection against extreme dysregulation, but it certainly does not take away the psychological burden facing the patient, namely having to control diabetes while living a full life.[17] If only technology could solve that problem.

Conflict of interest statement
None

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115