

Are we realising the full potential of blood glucose monitoring?

David Cavan, Jan Hawthorn, on behalf of the Diabetes Monitoring Forum*

Introduction

Are we making optimum use of blood glucose monitoring? We raise this question because, although it is clear that blood glucose monitoring can contribute to diabetes control, how health professionals working in diabetes care actually use blood glucose monitoring to assist patient management or to facilitate self-management is less clear. By examining a number of key issues in this article, we hope to stimulate discussion around this very important aspect of diabetes management.

The Diabetes Control and Complications Trial (DCCT, 1993) demonstrated what many clinicians had suspected for decades, namely that tight glycaemic control significantly delayed or prevented the long-term complications of type 1 diabetes. This finding was confirmed for people with type 2 diabetes by the large UK Prospective Diabetes Study (UKPDS) group (UKPDS, 1998; Gray et al, 2000). The remit for optimal management of people with diabetes must therefore be tight glycaemic control.

Some 20 years before these definitive studies, the introduction of small, portable blood glucose monitors had raised new possibilities for the management of diabetes. People could now measure their own blood glucose anywhere and at any time.

Self blood glucose monitoring (SBGM) was heralded as a new tool that could produce a sustained improvement in glycaemic control, and rapidly became the cornerstone of diabetes management. SBGM is now widely recommended as an essential part of care for people with diabetes (American Diabetes Association [ADA], 2001a). Yet 25 years on, glycaemic

control remains poor in a significant number of people with diabetes.

So, does poor glycaemic control reflect the fact that people with diabetes do not appreciate the value of SBGM? Undoubtedly SBGM can be of immense value. Self-monitoring of blood glucose enables some of those treated with insulin to take control of their diabetes, allowing them to adjust their own insulin dosage or diet in the light of their results. It is an invaluable tool that allows people with diabetes to explore their own metabolic responses to particular meals, or exercise, and can help them adjust their insulin to changing circumstances during illness.

For these people, the ability to take an instant measurement of their blood glucose is extremely helpful: it improves quality of life and amply justifies the inconvenience of carrying the test equipment around and the discomfort of testing (Gallichan, 1997).

Self-monitoring is particularly useful during pregnancy and for women planning a pregnancy, and it is the only method of self-testing that can detect hypoglycaemia. In addition, some people find it reassuring to have a readily available method to confirm or rule out hypoglycaemia.

However, there are also drawbacks to SBGM, such as embarrassment about having to test, the inconvenience, and feelings of guilt engendered by not meeting prescribed targets (Gallichan, 1997).

For patients with type 2 diabetes who are not on insulin therapy, there is less

ARTICLE POINTS

1 Optimal management of diabetes should include tight glycaemic control.

2 Portable monitors should facilitate self blood glucose monitoring (SBGM) and improve glycaemic control, but this effect is not being seen in the clinic.

3 The problem may be insufficient attention to what patients *do* with their blood glucose results.

4 People may not have sufficient information to use SBGM effectively.

5 This highlights the need for more patient education about SBGM.

KEY WORDS

- Blood glucose
- Self-monitoring
- Portable monitors
- Glycaemic control
- Patient education

*Sue Benbow, Consultant Physician, The Diabetes Department, Bolton Hospital; Sue Cradock, Consultant Nurse in Diabetes, Queen Alexandra Hospital, Portsmouth; David Cavan, Consultant & Honorary Senior Lecturer, Royal Bournemouth Hospital; Jeremy Dale, Professor of Primary Healthcare Studies, University of Warwick; Stephen Greene, Consultant Paediatrician, Ninewells Hospital and Medical School, Dundee; Jan Hawthorn, Diabetes Monitoring Forum Secretariat; Sharon Jones, Consultant Physician/Diabetologist, Good Hope Hospital, Sutton Coldfield; David Matthews, Professor of Diabetic Medicine, Churchill Hospital, Oxford; Gerry Rayman, Consultant Physician, Ipswich Diabetes Centre; Tara Wallace, Clinical Research Fellow, Churchill Hospital, Oxford

David Cavan is Consultant Physician and Honorary Senior Lecturer, Bournemouth Diabetes and Endocrine Centre, and Jan Hawthorn is Diabetes Monitoring Forum Secretariat.

PAGE POINTS

1 The DCCT provided evidence for the effectiveness of a package of care that includes self-monitoring.

2 SBGM has the potential to facilitate optimal diabetes control, yet in practice this potential is not being realised.

3 Studies have tried to correlate SBGM and glycaemic control, but have made no mention of what patients were actually doing with their blood glucose results.

4 The question is not whether SBGM alone leads to improved control, but whether patients have enough information to use SBGM to facilitate improved control.

5 People with diabetes should not just be taught to self monitor – they must also be thoroughly educated in how monitoring can be translated into better self-management.

agreement on the benefits of SBGM. The risk of hypoglycaemia is low with some oral agents, such as metformin, and for those trying to focus on diet and exercise, blood glucose measurements may be unnecessary or even distracting.

Some authors have questioned whether there is any value in performing SBGM at all in type 2 diabetes (Fontebonne et al, 1989; Patrick et al, 1994). Indeed, SBGM has been actively criticised on the basis that indiscriminate use of glucose monitoring wastes resources and causes psychological harm (Gallichan, 1997).

Even accepting these considerations, the results of the DCCT provide evidence for the effectiveness of a package of care for people with type 1 diabetes, and current clinical practice recommendations from the ADA encourage the use of self-monitoring in both type 1 and type 2 diabetes.

A potential not realised

So we are presented with a predicament – in theory, SBGM has the potential to facilitate optimal control of diabetes, yet in practice this potential is not being realised. But could it be that the conclusions of the negative studies are painting too simple a picture? Closer inspection of the results suggests that the reality is more complex.

For example, Fontebonne et al (1989) randomised 208 non-insulin-treated, poorly controlled people with diabetes to three groups: one with regular HbA_{1c} monitoring; one with self urine glucose monitoring and one with SBGM. Although there was only a small difference in HbA_{1c} improvement between the groups carrying out blood monitoring and urine monitoring (0.4% vs 0.1%), and the authors concluded that regular self-monitoring has no advantage over usual management, there was a significant correlation between the number of glucose strips used and decrease in HbA_{1c}.

Another important point is that while studies have looked at SBGM and glycaemic control and tried to correlate these two variables, no mention is made of what patients were actually doing with their blood glucose results. The question, therefore, is not whether SBGM alone leads to improved control, but whether patients have enough information to use SBGM in an

effective way to facilitate improved control.

It is common clinical experience that many people with diabetes test their blood glucose but do nothing in response to the result. They may dutifully record readings in a diary over many months, which they then present at their next clinic visit, without appreciating why they are testing their blood glucose, or what they should be doing with the result.

This is illustrated by the study of Patrick et al (1994), which showed no difference in HbA_{1c} between people who monitored and those who did not. However, only 22% of those who monitored kept a record of their results, and 62% would never alter their treatment on the basis of their results.

It is likely, therefore, that we will only see a correlation between blood glucose monitoring and glycaemic control in patients who are able and prepared to take some action in response to their blood glucose readings.

Other authors have expressed similar opinions:

- Fontebonne et al (1989) concluded that 'regular self-monitoring has no definite advantage over the usual management for improving metabolic control in non-insulin-treated diabetic patients, though it may possibly help patients ready to comply with its use'.
- Leese et al (1994) suggested that the benefit of SBGM would be greater if patients were carefully selected for their ability and willingness to use SBGM.
- In an editorial commentary, Natrass (2002) sums up the situation: 'Without input by any healthcare professional on the how, when, and what to do with the results of home blood glucose monitoring, it seems small wonder that results are less than exemplary.'

Education is essential

Thus people with diabetes should not just be taught how to self monitor – they must also be thoroughly educated in how to translate monitoring into better self-management. To quote the ADA (2001b):

'Medical treatment of diabetes without systematic self-management education can be regarded as substandard and unethical care.'

But is this happening? A recent survey in Norway (Skeie et al, 2002), which evaluated blood glucose monitors, showed that for the majority of patients the choice of instrument was not based on advice from healthcare personnel, suggesting a shortage of professional input at the onset of monitoring. A total of 51% of the patients claimed to be self-educated in performing SBGM, and doctors educated only 2%. Of the respondents, 74% never or rarely questioned the correctness of their instruments.

The value of education has been elegantly demonstrated in the detailed study by Franciosi and colleagues (2001) who showed that it was the patients who practised SBGM more than once a day and were able to adjust insulin doses who had significantly lower HbA_{1c} levels. What emerges in this study is that SBGM alone is insufficient to improve glycaemic control (and studies that just look at these two parameters miss the point) unless it is accompanied by adequate patient education to allow patients to understand and act upon the information that blood glucose values provide.

In this context it is worth noting that SBGM is used less frequently by older people and less educated people, who may be less able to cope with self-adjusting their insulin doses (Scorpiione et al, 1996).

A systematic review of the effectiveness of self-management training in type 2 diabetes (which reviewed 72 studies described in 84 articles) found positive effects of self-management training on knowledge, frequency and accuracy of SBGM, self-reported dietary habits and glycaemic control in studies with short follow-up (<6 months) (Norris et al, 2001). Effects of interventions on lipids, physical activity, weight and blood pressure were variable. A further study by this group has shown that education in self-management also improves HbA_{1c} levels (Norris et al, 2002).

What type of education is most effective?

Besides acknowledging that education is essential, it is also important to consider what type of education is most effective.

Generally, educative processes with people with diabetes have evolved away from a didactic approach towards a more interactive intervention, where a partnership is established between the person with diabetes and the healthcare professional (Korhonen et al, 1983).

Norris et al (2001) showed that didactic interventions increased knowledge but had less effect on blood glucose and blood pressure control, whereas educational initiatives that involved patient collaboration were more effective in improving glycaemic control, weight and lipid profiles.

However, a worrying observation is that the benefits of education decrease over time and can cease at 1–3 months after the educational initiative (Norris et al, 2002), demonstrating the need for continued input to maintain patient motivation. It has been suggested that assessing patients' level of understanding of their condition as part of routine treatment, as well as social factors, will help decide the degree and type of education that might be most appropriate (Home et al, 2002).

Conclusion

Taken together, these observations suggest that the full potential of SBGM will only be realised when it is used as part of a structured educational initiative. If SBGM can be used effectively then patients are more likely to continue monitoring. Strategies to maintain self-management skills, including SBGM, over the longer term are a crucial step in maintaining optimal glucose control.

It is therefore essential to identify the most effective way of educating patients in SBGM. This is likely to include a structured education programme, backed up by clear written information and updates to provide ongoing support.

Structured patient education is the exception rather than the rule in the UK, in contrast to many other European countries and the USA. Such programmes are likely to be a requirement of implementation of the NSF for Diabetes. The recent introduction of the DAFNE (Dose Adjustment For Normal Eating) programme, and other similar initiatives, demonstrates that such programmes can

PAGE POINTS

1 For the majority of patients the choice of instrument was not based on advice from healthcare personnel, suggesting a shortage of professional input at the onset of monitoring.

2 SBGM is used less frequently by older people and less educated people, who may be less able to cope with self-adjusting their insulin doses.

3 It is important to consider what type of education is most effective.

4 Educational initiatives that involved patient collaboration were more effective in improving glycaemic control, weight and lipid profiles.

5 The benefits of education decrease over time and can cease at 1–3 months after the educational initiative.

PAGE POINTS

1 Observations suggest that the full potential of SBGM will only be realised when it is used as part of a structured educational initiative.

2 If SBGM can be used effectively then patients are more likely to continue monitoring.

3 It is essential to identify the most effective way of educating patients in SBGM.

4 Structured patient education is likely to be a requirement of implementation of the Diabetes NSF.

5 The full potential of SBGM can only be realised by improving appreciation of what blood glucose monitoring means.

be adopted in the UK (DAFNE Study Group, 2002). We can improve the way that people monitor their blood glucose by providing advice or guidelines that can be adjusted to meet individual needs. The full potential of SBGM can only be realised by improving appreciation of what blood glucose monitoring means. ■

ACKNOWLEDGEMENTS: *This paper was funded by an unrestricted educational grant from MediSense® to the Diabetes Monitoring Forum to support education initiatives on blood glucose monitoring for people with diabetes. For further information on the Diabetes Monitoring Forum and the 'Reasons for testing your blood glucose', go to <http://www.dmfforum.org.uk>.*

American Diabetes Association (ADA) (2001a) Tests of glycaemia in diabetes. *Diabetes Care* **24**: S80–S83

American Diabetes Association (ADA) (2001b) Clinical practice recommendations 2001: standards of medical care for patients with diabetes mellitus. *Diabetes Care* **24** (Suppl 1): S33–S34

DAFNE Study Group (2002) Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial. *British Medical Journal* **325**(7367): 746

Diabetes Control and Complications Trial Research Group (1993) The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *New England Journal of Medicine* **329**: 977–86

Fontebonne A, Billault M, Acosta M et al (1989) Is glucose self-monitoring beneficial in non-insulin treated patients? *Diabetes and Metabolism* **15**: 255–60

Franciosi M, Pellegrini F, De Beradis G et al (2001) The impact of blood glucose self monitoring on metabolic control and quality of life in type 2 diabetic patients. *Diabetes Care* **24**: 1870–7

Gallichan M (1997) Self monitoring of glucose by people with diabetes: evidence-based practice. *British Medical Journal* **314**: 964–7

Gray A, Raikou M, McGuire A et al (2000) Cost effectiveness of an intensive blood glucose control policy in patients with type 2 diabetes: economic analysis alongside randomised controlled trial (UKPDS 41). *British Medical Journal* **320**: 1373–8

Home P, Chacra A, Chan J et al, on behalf of the Worldwide Initiative for Diabetes Education (2002) Considerations on blood glucose management in type 2 diabetes mellitus. *Diabetes Metabolism Research Reviews* **18**: 273–85

Korhonen T, Huttunen JK, Aro A et al (1983) A controlled trial on the effects of patient education in the treatment of insulin-dependent diabetes. *Diabetes Care* **6**: 256–61

Leese GP, Jung RT, Newton RW (1994) Home glucose monitoring in patients aged over 40 years with diabetes mellitus. *Practical Diabetes* **11**: 32–4

Nattrass M (2002) Improving results for home blood-glucose monitoring: accuracy and reliability require greater patient education as well as improved technology. *Clinical Chemistry* **48**: 979–80

Norris SL, Engelgau MM, Venkat Narayan KM (2001) Effectiveness of self-management training in type 2 diabetes: a systematic review of randomized controlled trials. *Diabetes Care* **24**: 561–87

Norris SL, Lau J, Smith SJ et al (2002) Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycaemic control. *Diabetes Care* **25**: 1159–71

Patrick AW, Gill GV, MacFarlane IA et al (1994) Home glucose monitoring in type 2 diabetes: is it a waste of time? *Diabetic Medicine* **11**: 62–5

Scorpiglione N, El-Shazly M, Abdel-Fattah M et al (1996) Epidemiology and determinants of blood glucose self-monitoring in clinical practice. *Diabetes Research and Clinical Practice* **34**: 115–25

Skeie S, Thue G, Nerhus K et al (2002) Instruments for self-monitoring of blood glucose: comparisons of testing quality achieved by patients and a technician. *Clinical Chemistry* **48**: 994–1003

UK Prospective Diabetes Study (UKPDS) Group (1998) Intensive blood glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* **352**: 837–53