

Self-monitoring of blood glucose: To test or not to test?

Debbie Hicks

Article points

1. Regular blood glucose monitoring to reduce the incidence of severe hypoglycaemic episodes appears to be a reasonable and evidence-based use of resources.
2. When considering a choice of blood glucose meter, it is important to consider the independent evidence available for each meter to ensure that a cost-effective product is used.
3. NHS Enfield implemented a preferred list of four meters and an evidence-based policy.
4. NHS Enfield were able to rationalise the number of meters available and reduce expenditure on test strips, while ensuring that those who need to test continue to do so.

Key words

- Blood glucose monitoring
- Cost-effectiveness
- Hypoglycaemia
- Self-monitoring of blood glucose

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Blood glucose testing is an area of diabetes prescribing, with the cost to the NHS rapidly approaching £175 million per year in the UK. A number of clinical trials have debated its clinical and cost-effectiveness, especially in certain patient groups. This article is designed to review the evidence and provide information to help guide decisions on whether blood glucose testing is cost-effective. The author describes the experience of NHS Enfield in developing an evidence-based policy that led to the reduction of blood glucose test strip expenditure without compromising the availability of tests to those who need it.

The White Paper *Equity and Excellence: Liberating the NHS* (Department of Health, 2010) suggests a number of ways to improve health care in the current fiscal and political climate, including increasing patient engagement, increasing focus on outcomes and improving productivity. Therefore, all activities that clinicians undertake should be evidence-based to ensure best value.

Nearly £175 million per year is spent on blood glucose test strips in the UK (NHS National Prescribing Centre, 2009), but the effectiveness of this investment in people with type 2 diabetes who are not receiving insulin has been questioned. Both the DiGEM (Diabetes Glycaemic Education and Monitoring) trial (Farmer et al, 2007) and the ESMON (Efficacy of Self-Monitoring of Blood Glucose [SMBG] in Newly Diagnosed Type 2 Diabetes) study (O’Kane et al, 2008) failed to show any significant benefit of SMBG in insulin-naïve people with type 2 diabetes compared with no monitoring. The frequency of testing and education associated with the

testing also seemed to make little difference to the outcomes. The ESMON study even showed a slight increase (6%) in the depression index score in the monitoring group (O’Kane et al, 2008), reminding us that monitoring is not without detriment to wellbeing.

In this article, the author highlights the available guidance on the use of SMBG, provides information on how to make decisions on its cost-effectiveness and details practical experience of using such information to ensure cost-effectiveness in clinical practice.

SMBG and hypoglycaemia

SMBG can help to protect against the risk of hypoglycaemia that is associated with the use of antidiabetes medications. Severe hypoglycaemia can result in severe disablement, hospitalisation and even death. Therefore, regular monitoring to reduce the incidence of severe hypoglycaemic episodes appears to be a reasonable and evidence-based use of resources.

Guidance varies, but it is now commonly accepted that people taking insulin (with type 1 or type 2 diabetes) should be testing

regularly. For example, it is a requirement of the Driver and Vehicle Licensing Agency (DVLA, 2011) that drivers taking insulin, sulphonylureas and glinides test blood glucose levels regularly (*Box 1*). However, the value is much less clear in people with type 2 diabetes taking oral antidiabetes agents. NICE (2008) guidance (see *Box 2*) recommends that among people with type 2 diabetes, those who take insulin should be offered SMBG, but in people taking other antidiabetes medications it should only be used as part of self-management education.

Hypoglycaemia is a side-effect associated with some oral antidiabetes medications, most notably sulphonylureas. The rate of hypoglycaemia in those treated with a sulphonylurea (insulin secretagogues) has been estimated to be up to 30% (Gangji et al, 2007; Nathan et al, 2009). Furthermore, up to 10% of sulphonylurea-associated hypoglycaemia may be fatal (Gerich, 1989; Shorr et al, 1997). Therefore, blood glucose testing should not be prevented in this group of people.

SMBG frequency

In terms of frequency of SMBG, there is varied guidance. The American Diabetes Association (2009) recommends that people taking insulin should test their blood glucose levels three times per day, and Diabetes UK (2009) advises that testing should be agreed between an individual and their clinician based on current treatment and personal circumstances.

A pragmatic approach to the data seems to suggest that the ideal approach to blood glucose testing is “appropriate testing at the appropriate time for the appropriate individual with appropriate action taken from results”.

Blood glucose meters

In the UK, there are over 25 blood glucose meters currently being promoted to people with diabetes and healthcare professionals. Therefore, there is a wide selection available to meet all individuals’ needs, but for healthcare professionals this creates a challenge in understanding the operations of all the meter varieties. For this reason, a

Box 1. Guidance for drivers with insulin-treated diabetes (DVLA, 2011).

- You must regularly monitor your condition by checking your blood glucose levels at least twice daily and at times relevant to driving. We advise the use of memory chip meters for such monitoring.
- You must arrange to be examined every 12 months by a hospital consultant who specialises in diabetes.

Box 2. NICE (2008) recommendations for self-monitoring of plasma glucose.

- Offer self-monitoring of plasma glucose to a person newly diagnosed with type 2 diabetes only as an integral part of his or her self-management education. Discuss its purpose and agree how it should be interpreted and acted upon.
- Self-monitoring of plasma glucose should be available:
 - To those on insulin treatment.
 - To those on oral glucose-lowering medications to provide information on hypoglycaemia.
 - To assess changes in glucose control resulting from medications and lifestyle changes.
 - To monitor changes during intercurrent illness.
 - To ensure safety during activities, including driving.
- Assess at least annually and in a structured way:
 - Self-monitoring skills.
 - The quality and appropriate frequency of testing.
 - The use made of the results obtained.
 - The impact on quality of life.
 - The continued benefit.
 - The equipment used.
- If self-monitoring is appropriate but blood glucose monitoring is unacceptable to the individual, discuss the use of urine glucose monitoring.

rationalised meter choice may confer benefit to people with diabetes, only if an associated training programme is established to enable all healthcare professionals within a locality to have a sound understanding of how a meter works. It is important that this meter choice is a joint decision incorporating all stakeholders to allow for cost-effectiveness.

When considering a choice of meter, the three factors that people with diabetes consider the highest priority are ease of use (no coding), small sample size and rapid test time. It is also important to consider the

Table 1. Currently available test strips in the UK with no coding meters, as of August 2010.

Strip type ^A	Strip/meter brand ^A	UK supplier ^B	Drug tariff price ^A	Sample size (µL) ^B	Test time (s) ^B	Strip expiry after opening ^B
Biosensor disc	Breeze 2	Bayer Diabetes Care	£14.45	1	5	Until pack expiry
Biosensor strip	CareSens N	Spirit Healthcare	£12.75	0.5	<5	6 months
Biosensor strip	Clever Chek	BBI Healthcare	£16.30	0.7	7	90 days
Colorimetric strip	Accu-Chek Compact	Roche	£15.29	0.8	5	Until pack expiry
Biosensor strip	Contour	Bayer Diabetes Care	£14.85	0.6	5	6 months
Biosensor strip	FreeStyle Lite	Abbott Diabetes Care	£14.73	0.3	5	1 month
Biosensor strip	GlucoMen GM	Menarini	£14.67	0.5	7	2 months
Biosensor strip	GlucoMen LX Sensors	Menarini	£14.65	0.3	4	9 months
Biosensor strip	GlucoRx Strips	DiME	£9.95	0.7	7	3 months
Biosensor strip	Microdot+	Cambridge Sensors	£13.50	0.6	10	3 months
Biosensor strip	Myglucohealth	Entra Health Systems	£15.50	0.3	3	3 months
Biosensor strip	Mylife Pura	Ypsomed	£14.00	1	5	3 months
Biosensor strip	OneTouch Vita	LifeScan	£14.64	1	5	6 months
Biosensor strip	TRUEone	Home Diagnostics	£14.36	1	<10	3 months
Biosensor strip	TRUEresult	Home Diagnostics	£14.36	0.5	4+	3 months
Biosensor strip	WaveSense JAZZ	AgaMatrix	£14.36	0.5	5	90 days

^AData taken from *NHS Electronic Drug Tariff – August 2010* (NHS Prescription Services, 2010).
^BData taken from user guides, test strip inserts, medical information lines and websites, as of August 2010.

independent evidence available for each meter along with added-value services provided by the manufacturing companies (e.g. free meters, customer support, free replacement batteries) to ensure that a cost-effective product is used. *Table 1* lists the test strips that are given with the currently available blood glucose meters in the UK that are of the no-coding variety and provides additional information that is useful for supporting a rational decision.

Evidence into action

NICE (2008) provides guidance on who should be offered SMBG, what SMBG should

achieve and what aspects of SMBG should be assessed and how regularly (see *Box 2*), which should be carried out in a structured way and documented within the individual's care plan.

The most appropriate way to ensure adoption of these recommendations is for different healthcare professionals to work alongside each other to develop a local joint plan for blood glucose testing. Stakeholders involved may include secondary care diabetes teams, intermediate care diabetes teams, GPs, practice nurses and/or community pharmacists. A local plan should include:

- Who should and should not be testing.

- How frequently individuals should test their blood glucose levels.
- A rationalised meter choice and training plan for all stakeholders.
- A quality assurance scheme for all meters used by healthcare professionals.
- A review period for ensuring that the current plan remains up to date.

In the UK, an average of £300 000 is spent per 100 000 population on blood glucose testing strips (NHS National Prescribing Centre, 2009). A 20% cost saving on the prescription cost of strips and a 20% reduction in overall testing would realise a £108 000 saving per 100 000 population. For an average primary care trust (PCT) in England this may derive an annual recurrent saving of up to £324 000–432 000 (based on an average PCT population of 300 000–400 000) – enough to fund nine or 10 DSNs for 1 year (Royal College of Nursing, 2011).

The Enfield experience

In 2008, NHS Enfield identified that 25 different varieties of blood glucose meters were being used locally. This presented a significant challenge for local healthcare professionals to have an understanding of all the available meters.

NHS Enfield, therefore, decided to implement a preferred list of meters along with a robust evidence-based policy. This policy determined guidelines detailing who should be testing, how often, who may not be gaining clinical value (and, therefore, may stop testing) and whom in which it may be appropriate to change to the preferred local meter. After a process of identifying the key features required from a meter (small sample size, no coding, free meter availability) along with added-value services, evidence base and purchase cost of strips (see *Table 1* for a comparison list), NHS Enfield selected four preferred meters.

The policy was developed with engagement from all stakeholders, including primary care and secondary care staff and representatives from the local user group. The policy was then implemented with the assistance of the

same stakeholders, and also with engagement from 15 community pharmacies that agreed to reduce the number and type of meters sold in their stores. NHS Enfield also provided training for all healthcare professionals in relation to the new preferred meter choices and blood glucose testing policy, encouraging individual discussion with all people with diabetes on using test strips according to the new policy. This policy was based on the consensus statement for blood glucose monitoring by Owens et al (2005).

The result of implementing the new policy was a reduction in the overall blood glucose test strip prescription expenditure by £500 000 over 2 years, making NHS Enfield the trust with the fourth lowest prescription cost of blood glucose test strips per head of people with diabetes in England.

Patient feedback throughout the process was positive. This demonstrates that it is possible to rationalise the number of meters available and reduce expenditure on test strips, while ensuring that those who need to test continue to do so. Assuming a UK population of 61.8 million (Office for National Statistics, 2010) and an NHS Enfield population of approximately 290 000 (www.enfield.nhs.uk), if this reduction in prescribing was extrapolated across the NHS, a potential productivity saving of approximately £106 million may be possible.

Conclusion

Good glycaemic control is important to reduce the risk of microvascular complications such as renal and eye disease (DCCT [Diabetes Control and Complications Trial] Research Group, 1993; UKPDS [UK Prospective Diabetes Study] Group, 1998). For people with diabetes to maintain good glycaemic control, access to the right tools is necessary, which includes blood glucose monitoring. The author believes that what is currently lacking in primary care trusts is a robust educational programme for both people with diabetes and healthcare professionals that identifies who should be testing their blood glucose levels, how often

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and which is the most appropriate meter. Such a programme also needs to include all those people who are currently testing but may not be gaining any clinical value from doing so. A preferred range of meters can bring benefits, in that all the healthcare professionals will be familiar with the meters' specifications. These changes could lead to reduced costs, as has been shown in Enfield.

The NICE guidance on the management of type 2 diabetes is currently under review. Given the lack of evidence for benefit of SMBG in people with type 2 diabetes not treated with insulin, it is likely to be recommended that SMBG is not encouraged in these individuals. Unfortunately, this recommendation would contradict the DVLA (2011) guidance that people taking sulphonylureas or glinides regularly test blood glucose levels. ■

American Diabetes Association (2009) Standards of medical care in diabetes – 2009. *Diabetes Care* **32**: S13–61

Department of Health (2010) *Equity and Excellence: Liberating the NHS*. DH, London. Available at: <http://bit.ly/cCOMnL> (accessed 25.05.11)

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. *N Engl J Med* **329**: 977–86

Diabetes UK (2009) *Position Statement: Self-monitoring of Blood Glucose*. Diabetes UK, London. Available at: <http://bit.ly/mw7aDd> (accessed 25.05.11)

Driver and Vehicle Licensing Agency (2011) *At a Glance Guide to the Current Medical Standards of Fitness to Drive*. DVLA, Swansea. Available at: <http://bit.ly/a2HTeC> (accessed 13.06.11)

Farmer A, Wade A, Goyder E et al (2007) Impact of self monitoring of blood glucose in the management of patients with non-insulin treated diabetes: open parallel group randomised trial. *BMJ* **335**: 132

Gangji AS, Cukierman T, Gerstein HC et al (2007) A systematic review and meta-analysis of hypoglycemia and cardiovascular events: a comparison of glyburide with other secretagogues and with insulin. *Diabetes Care* **30**: 389–94

Gerich JE (1989) Oral hypoglycaemic agents. *N Engl J Med* **321**: 1231–45

Nathan DM, Buse JB, Davidson MB et al (2009) Medical management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy: a consensus statement of the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care* **32**: 193–203

NHS National Prescribing Centre (2009) *Type 2 Diabetes – Self-monitoring of Blood Glucose in Type 2 Diabetes*. NHS NPC, Liverpool. Available at: <http://bit.ly/lnaZCt> (accessed 13.06.11)

NHS Prescription Services (2010) *NHS Electronic Drug Tariff – August 2010*. NHS Prescription Services, Newcastle upon Tyne. Available at: <http://bit.ly/m7mehm> (accessed 13.06.11)

NICE (2008) *Type 2 Diabetes: The Management of Type 2 Diabetes*. NICE, London. Available at: <http://bit.ly/6SkM1G> (accessed 25.05.11)

Office for National Statistics (2010) *Population Estimates Statistical Bulletin – Mid 2009*. ONS, Newport. Available at: <http://bit.ly/9pk10R> (accessed 13.06.11)

O’Kane MJ, Bunting B, Copeland M et al (2008) Efficacy of self monitoring blood glucose in patients with newly diagnosed type 2 diabetes (ESMON study): randomised controlled trial. *BMJ* **336**: 1174–7

Owens D, Pickup J, Barnett AH et al (2005) The continuing debate on self-monitoring of blood glucose in diabetes. *Diabetes and Primary Care* **7**: 9–21

Royal College of Nursing (2011) *NHS Agenda for Change Pay Scales – 2011/12*. RCN, London. Available at: <http://bit.ly/mhfDXy> (accessed 13.06.11)

Shorr RI, Ray WA, Daugherty JR, Griffin MR (1997) Incidence and risk factors for serious hypoglycemia in older persons using insulin or sulphonylureas. *Arch Intern Med* **157**: 1681–6

UK Prospective Diabetes Study 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