Self-monitoring in Diabetes Mellitus

The role of glucose monitoring

**Self-monitoring of blood glucose** is considered an effective tool for the management of diabetes, especially for those who require insulin treatment.[1]

Self-monitoring gives regular feedback for the patient; however, decisions on both the method and frequency of testing need to be made on an individual basis. Monitoring is only useful if it is used to inform decisions (eg, adjusting tablets or insulin dosage).

Diabetes empowerment improves diabetes self-care behaviours (including diet, physical activity, blood glucose monitoring and foot care).[2] Studies have shown that when patients perform self-monitoring, support through appropriate educational initiatives is critical to ensure that patients understand the rationale for self-monitoring of blood glucose.[3] See also separate Diabetes Education and Self-management Programmes article.

Methods of monitoring glucose

Various methods of glucose monitoring are available, including HbA1c measurement, blood glucose monitoring and urine testing. **NB:** urine testing is not recommended but may be useful for some patients with diet- or tablet-controlled type 2 diabetes mellitus - for example, as a warning sign of high glucose levels when unwell.

**Blood glucose monitoring**[4]

Blood glucose monitoring using a meter gives a direct measure of the glucose concentration at the time of the test and can detect hypoglycaemia as well as hyperglycaemia.

Patients should be properly trained in the use of blood glucose monitoring systems and to take appropriate action on the results obtained. Inadequate understanding of the normal fluctuations in blood glucose can lead to confusion and inappropriate action.

Although glucose meters are not prescribable at NHS expense, manufacturers often provide them free to patients, on the basis of income made from the testing strips, which are prescribable at NHS expense and each type of testing strip is specific to each monitor.

**Urine glucose testing**[5]

- Urine testing is best undertaken in the morning before breakfast. The bladder should be emptied when the person first gets up from bed and a sample, passed 30 minutes later, tested. Tests done at this time should be negative. Testing can also be done two to three hours after a meal, when blood glucose will have been at its highest.
- Urine testing gives a less accurate picture of blood glucose than blood testing and does not give an indication of the blood glucose level because the urine tested may have been produced several hours before the test. Urine tests also don't indicate if blood glucose is too low.
- The results of urine testing are also dependent on the individual person's renal threshold for glucose.
- Urine testing involves comparing a colour change on the urine testing strip and is not suitable for the visually impaired.

**Urine ketone testing**[6]

People with diabetes should also routinely be given urine testing strips so they can test their urine for ketones (particularly if their blood glucose is high (usually over 15 mmol/L) or if they have any symptoms of illness) and advised to seek medical advice if ketones are present.

**Continuous glucose monitoring (CGM)**

Subcutaneous CGM machines show real-time glucose on the monitor every five minutes and have alarms to indicate hypoglycaemia and hyperglycaemia. However, there is no clear consensus about the clinical indications for CGM in actual clinical practice[7].

A Cochrane review found that there is limited evidence for the effectiveness of real-time CGM use in children, adults and patients with poorly controlled diabetes. However, there were indications that higher compliance of wearing the CGM device improved glycosylated HbA1c level to a larger extent[8].

**Type 1 diabetes**

**Adults with type 1 diabetes**[9]

- Advise routine self-monitoring of blood glucose levels for all adults with type 1 diabetes and recommend testing at least four times a day, including before each meal and before bed. Support adults with type 1 diabetes to test up to 10 times a day if any of the following apply:
  - The desired target for blood glucose control, measured by HbA1c level, is not achieved.
- The frequency of hypoglycaemic episodes increases.
- There is a legal requirement to do so, such as before driving, in line with the Driver and Vehicle Licensing Agency (DVLA).
- During periods of illness.
- Before, during and after sport.
- When planning pregnancy, during pregnancy and while breast-feeding.
- If there is a need to know blood glucose levels more than four times a day for other reasons - eg, impaired awareness of hypoglycaemia, high-risk activities.

- Enable additional blood glucose testing (more than 10 times a day) for adults with type 1 diabetes if this is necessary because of the person's lifestyle (eg, driving for a long period of time, undertaking high-risk activity or occupation, travel) or if the person has impaired awareness of hypoglycaemia.
- Blood glucose targets:
  - Advise adults with type 1 diabetes to aim for a fasting plasma glucose level of 5-7mmol/L on waking and a plasma glucose level of 4-7mmol/L before meals at other times of the day.
  - Advise adults with type 1 diabetes who choose to test after meals, to aim for a plasma glucose level of 5-9 mmol/L at least 90 minutes after eating. This timing may be different in pregnancy.
  - Agree bedtime target plasma glucose levels with each adult with type 1 diabetes that take into account timing of the last meal and its related insulin dose and are consistent with the recommended fasting level on waking.

- Empowering people to self-monitor blood glucose: teach self-monitoring skills at the time of diagnosis and initiation of insulin therapy.
- When choosing blood glucose meters:
  - Take the needs of the adult with type 1 diabetes into account.
  - Educate adults with type 1 diabetes about how to measure their blood glucose level, interpret the results and know what action to take. Review these skills at least annually.
  - Support adults with type 1 diabetes to make the best use of data from self-monitoring of blood glucose through structured education.

- Sites for self-monitoring of blood glucose: monitoring blood glucose using sites other than the fingertips cannot be recommended as a routine alternative to conventional self-monitoring of blood glucose.
Continuous glucose monitoring:
- Do not offer real-time continuous glucose monitoring routinely to adults with type 1 diabetes.
- Consider real-time continuous glucose monitoring for adults with type 1 diabetes who are willing to commit to using it at least 70% of the time and to calibrate it as needed, and who have any of the following despite optimised use of insulin therapy and conventional blood glucose monitoring:
  - More than one episode a year of severe hypoglycaemia with no obviously preventable precipitating cause.
  - Complete loss of awareness of hypoglycaemia.
  - Frequent (more than two episodes a week) asymptomatic hypoglycaemia that is causing problems with daily activities.
  - Extreme fear of hypoglycaemia.
  - Hyperglycaemia (HbA1c level of 75 mmol/mol (9%) or higher) that persists despite testing at least 10 times a day.
- Continue real-time continuous glucose monitoring only if HbA1c can be sustained at or below 53 mmol/mol (7%) and/or there has been a fall in HbA1c of 27 mmol/mol (2.5%) or more.
- For adults with type 1 diabetes who are having real-time continuous glucose monitoring, use the principles of flexible insulin therapy with either a multiple daily injection insulin regimen or continuous subcutaneous insulin infusion therapy.
- Real-time continuous glucose monitoring should be provided by a centre with expertise in its use, as part of strategies to optimise a person's HbA1c levels and reduce the frequency of hypoglycaemic episodes.
- Consider ketone monitoring (blood or urine) as part of ‘sick-day rules’ for adults with type 1 diabetes, to facilitate self-management of an episode of hyperglycaemia.

Children and young adults with type 1 diabetes
- Advise children and young people with type 1 diabetes and their family members or carers to routinely perform at least five capillary blood glucose tests per day.
- Offer ongoing real-time continuous glucose monitoring with alarms to children and young people with type 1 diabetes who have:
  - Frequent severe hypoglycaemia; or
  - Impaired awareness of hypoglycaemia associated with adverse consequences (eg, seizures or anxiety); or
  - Inability to recognise, or communicate about, symptoms of hypoglycaemia (eg, because of cognitive or neurological disabilities).
- Explain to children and young people with type 1 diabetes and their family members or carers that they should always have access to an immediate source of fast-acting glucose and blood glucose monitoring equipment for immediate confirmation and safe management of hypoglycaemia.
- Offer children and young people with type 1 diabetes blood ketone testing strips and a meter and advise them and their family members or carers to test for ketonaemia if they are ill or have hyperglycaemia.

Type 2 diabetes

National Institute for Health and Care Excellence (NICE) recommendations for patients with type 2 diabetes
- Do not routinely offer self-monitoring of blood glucose levels for adults with type 2 diabetes unless:
  - The person is on insulin; or
  - There is evidence of hypoglycaemic episodes; or
  - The person is on oral medication that may increase their risk of hypoglycaemia while driving or operating machinery; or
  - The person is pregnant, or is planning to become pregnant.
- Consider short-term self-monitoring of blood glucose levels in adults with type 2 diabetes (and review treatment as necessary):
  - When starting treatment with oral or intravenous corticosteroids; or
  - To confirm suspected hypoglycaemia.
- If adults with type 2 diabetes are self-monitoring their blood glucose levels, carry out a structured assessment at least annually. The assessment should include:
  - The person's self-monitoring skills.
  - The quality and frequency of testing.
  - Checking that the person knows how to interpret the blood glucose results and what action to take.
  - The impact on the person's quality of life.
  - The continued benefit to the person.
  - The equipment used.

People with type 2 diabetes who are not using insulin
- Although self-monitoring of blood glucose has been found to be effective for patients with type 1 diabetes and for patients with type 2 diabetes using insulin, evidence suggests that self-monitoring of blood glucose is of limited clinical effectiveness in improving glycaemic control in people with type 2 diabetes on oral agents or diet alone.
A Cochrane review found that the overall effect of self-monitoring of blood glucose on glycaemic control in patients with type 2 diabetes who are not using insulin is small up to six months after initiation and subsides after 12 months. There was no evidence that self-monitoring of blood glucose affected patient satisfaction, general well-being or general health-related quality of life.

Further reading & references

- Management of diabetes; Scottish Intercollegiate Guidelines Network - SIGN (March 2010 - updated Sept 2013)
- Diabetes UK
- Assessing fitness to drive: guide for medical professionals; Driver and Vehicle Licensing Agency
- British National Formulary (BNF); NICE Evidence Services (UK access only)
- Managing your diabetes - blood glucose levels; Diabetes UK
- Diabetic Ketoacidosis (DKA); Diabetes UK
- Type 1 diabetes in adults: diagnosis and management; NICE Guidelines (August 2015, updated July 2016)
- Diabetes (type 1 and type 2) in children and young people: diagnosis and management; NICE Guidelines (Aug 2015, updated Nov 2016)
- Type 2 diabetes in adults: management; NICE Guidelines (December 2015, updated May 2017)

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Peer Reviewer:
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Document ID:
455 (v6)

Last Checked:
02/12/2016

Next Review:
01/12/2021

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