t·r·e·n·d™ DIABETES

For Healthcare Professionals:

MONITORING IN ADULT DIABETES: GLUCOSE AND KETONES

CONTENTS

ABOUT THIS GUIDANCE

Authors

June James: Nurse Consultant-Diabetes, Co-Chair Trend Diabetes
Debbie Hicks: Nurse Consultant-Diabetes, Co-Chair Trend Diabetes
Erica Richardson: Lead Diabetes Specialist Nurse, Trend Diabetes Associate
Elizabeth Camfield: Senior Diabetes Nurse Specialist, Trend Diabetes Committee Member
Anne Currie: Lead Nurse, Trend Diabetes Committee Member

About Trend Diabetes

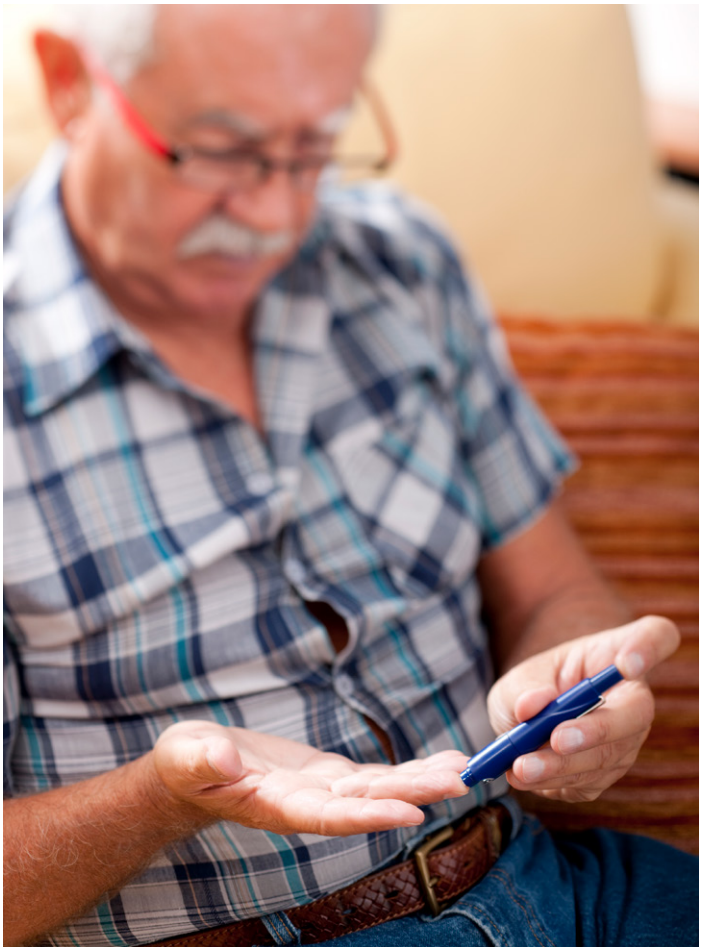
Trend Diabetes produces a number of resources for healthcare professionals and people living with diabetes. These are available at www.trenddiabetes.online. Access to these resources is free of charge to anyone registering as a member of Trend Diabetes.

INTRODUCTION

Individuals living with diabetes resident in the United Kingdom are monitored by the National Health Service for a variety of reasons.

These include:

- To encourage access of early interventions to promote a long and healthy life and reduce the risk of diabetes complications
- To identify those at higher risk of developing other health problems and offer them the opportunity to make informed choices[1]
- To facilitate, where possible, a good quality of life
- To prevent clinical inertia.



The diabetes annual review is most often used for monitoring health and well being but the percentage of people with diabetes receiving all their health checks is low, with 1 in 5 people with type 1 diabetes and 2 in 5 with type 2 diabetes achieving clinical targets for glucose, blood pressure and lipids.[2] Educational opportunities and the maximising of diabetes therapies are important parts of this process.

Where monitoring is undertaken, it is important that the tests used are appropriate and accurate and that the healthcare professional (HCP) recognises what the results indicate and which other factors may need to be considered.

This document provides information on common tests used in glycaemic and ketone monitoring - these can signpost to where urgent action is needed to prevent ill health.

There are a variety of methods used to monitor the impact of therapies, lifestyle choices, co-morbidities, and inter-current illness on glycaemic control. These include:

- HbA1c
- Blood glucose monitoring (capillary blood)
- Continuous glucose monitoring (CGM) (interstitial fluid) and intermittently scanned CGM

HbA1c (GLYCATED HAEMOGLOBIN)

The HbA1c (glycated haemoglobin) reflects the exposure to prevailing glucose levels during the lifespan of red blood cells (approximately 120 days, but 50% of the value reflects the last 30 days).[3]

HbA1c targets in type 1 diabetes

- Individualise HbA1c target with each adult with type 1 diabetes. Consider factors such as the individuals' daily activities, aspirations, likelihood of complications, comorbidities, occupation and history of hypoglycaemia
- Ensure that HbA1c target is not accompanied by problematic hypoglycaemia
- Aim for a target HbA1c of 48mmol/mol
- Measure HbA1c levels every 3-6months.
- Consider measuring HbA1c levels more often in adults with type 1 diabetes if the person's blood glucose control is suspected to be changing rapidly; for example, if the HbA1c level has risen unexpectedly above a previously sustained target, rapid adjustment in lifestyle or therapy adjustment.
- CGM use in type 1 diabetes can indicate a HbA1c target (GMI) glucose management indicator which uses the glucose measurements collated by the system over a 2 week period. It can also indicate time spent in range (TIR) i.e glucose levels between 3.9 -10 mmols. This could be used in conjunction with lab results to support decision making.[4]

⚠ **If HbA1c monitoring is invalid because of disturbed erythrocyte turnover or abnormal haemoglobin type, estimate trends in blood glucose control using 1 of the following:**

- **Fructosamine estimation**
- **Quality-controlled blood glucose profiles**
- **Total glycated haemoglobin estimation (if abnormal haemoglobins).[5,6]**

HbA1c targets for people already diagnosed with type 2 diabetes:

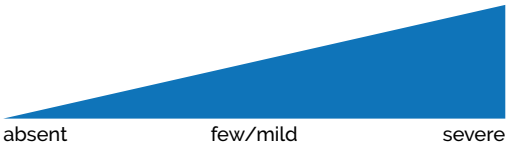
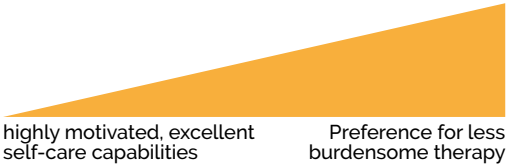
- Each person should discuss and agree their individual HbA1c target with their healthcare professional.
- HbA1c should be measured at least every Change to 3-6 months and 6 months once HbA1c and therapies are stable.[6]
- The recommended targets for people with type 2 diabetes are:
  - An HbA1c level of 48 mmol/mol, to minimise the risk of long-term vascular complications at diagnosis (type 2 diabetes) in those not taking a sulphonylurea or insulin.
  - If the individual is taking a medication associated with hypoglycaemia, the target HbA1c is 53 mmol/l.
  - If the HbA1c increases to 58 mmol/mol in type 2 diabetes, NICE (2020) advise adding in additional therapy and then aiming for 53 mmol/mol.

⚠ **People who are frail and/or older or those with multiple comorbidities will require different glycaemic targets to ensure safety, according to the consensus recommendations:[7]**

- **In people with diabetes and mild-moderate frailty, the HbA1c recommended target is 53-64 mmol/mol**
- **In people with diabetes and severe frailty, the recommended target is 59-69 mmol/mol .[7]**

There are other factors which influence a decision for a specific HbA1c target; Table 1 offers a simple guide for HCPs to assess how stringent the HbA1c target needs to be.

Table 1: Approach to individualised glycaemic targets.[8]

Patient/Disease Features	More Stringent ❮ HbA1 7% (53mmol/mol) ❯ Less Stringent	
Risks potentially associated with hypoglycaemia and other drug-related adverse effects		Usually not modifiable
Disease duration		
Life expectancy		
Important comorbidities		
Established vascular complications		
Patient preference		Potentially modifiable
Resources and support system		

Psychological impact of glucose testing

As many as 67% of people living with diabetes report monitoring their glucose levels less frequently than is desirable for good health.[9] The main reasons cited are:

- Discomfort or pain
- Dislike, fear or phobia of needles/sharps
- Inconvenience of testing
- Prioritising other life tasks and responsibilities
- Embarrassment
- Wanting to avoid reminders of diabetes.

Less invasive forms of monitoring such as CGM may overcome some of these factors. Barriers to glucose testing should be explored in the consultation with the healthcare professional. Whilst true needle phobia is rare, if present it will complicate self-management[10,11] and referral for psychological support is recommended.[12] Psychological interventions based on cognitive behavioural therapy can assist the person to understand their thoughts and feelings about monitoring and to develop strategies to overcome their difficulties.[12,13]

GLUCOSE MONITORING

The importance of glucose control in reducing the risk of complications in people with type 1 or type 2 diabetes is well established.[14-18] Both HbA1c and daily blood glucose variability influence this risk. The use of self-monitoring of blood glucose (SMBG) to facilitate the achievement of evidence-based blood glucose targets has increasingly been incorporated into routine management for many people with diabetes. Indeed, SMBG was described as possibly the most important advance in managing diabetes since the discovery of insulin (Weinstock et al. 2020).[19]

Cost of capillary blood glucose (BG) monitoring in the UK

Over 50 different types of blood glucose meters are available in the UK. The meters can be provided free of charge to people with diabetes through diabetes teams and practices, and the strips used with them are available on prescription. The cost of testing strips in 2022 was estimated to be £172 million.[20] Despite the financial constraints the NHS faces, it also has requirements to maintain quality, to afford newer, higher-cost treatments, to meet public expectations and to increase capacity to deliver healthcare services to all who need them. This has led to a consideration of how and where precious healthcare resources are used. Quality, Innovation, Productivity and Prevention (QIPP) recommended reviewing the routine prescribing of BG testing strips for people with type 2 diabetes who do not use insulin a number of years ago. They suggested this as an area where considerable financial savings could potentially be made for the NHS.

Individuals with type 1 diabetes many be offered any glucose or ketone monitoring system that adheres to local prescribing policy and / or links to other advance technologies i.e. insulin pump therapy. Individuals with type 2 diabetes who blood glucose test should know how to alter their medication if readings are out of range.

Some blood glucose meters have the ability to test blood glucose and blood ketones.

Improvements in monitors and linked systems has now enabled different functions to support Insulin dose adjustment and links for web based apps and other health based IT systems.

⚠ These recommendations do not include other agents that carry a risk of hypoglycaemia.

Table 2: The advantages and disadvantages of self-monitoring of capillary blood glucose.

Advantages
It enables the detection of hypoglycaemia and hyperglycaemia and can facilitate appropriate dietary and medication changes.
It informs people with diabetes and healthcare professionals when treatment changes are required to reduce the risk of short- and long-term complications.
It facilitates diabetes education and management, enabling individuals to self-manage their diabetes.
It informs the management of intercurrent illness and stress in order to reduce risk of acute metabolic decompensation (diabetic ketoacidosis and hyperosmolar hyperglycaemic state) and to avoid unplanned admission to hospital.
It can help motivate people toward healthier behaviour
Disadvantages
SMBG is an invasive technique and some individuals find finger pricking painful and uncomfortable.
Testing can be inconvenient. People who regularly test have to carry supplies and ensure they can dispose of sharps safely.
Testing is costly, particularly if the results do not facilitate treatment changes.
The finding of a high capillary glucose result may cause anxiety and contribute to a negative experience of diabetes and its management.
Some people find the requirement to monitor regularly oppressive and a constant reminder of their condition.[21]

Quality standards for blood glucose meters

All BG testing devices have to meet the current ISO standards. ISO (International Organization for Standardization) 15197:2013 (E) describes the requirements for blood glucose monitoring systems using capillary blood (ISO, 2013). Originally developed in 2003, the standards were revised to be more stringent and were published in 2013. All capillary blood glucose monitoring systems had to have met the 2013 ISO standards (not the 2003 standards) by 2016.

Haematocrit affects the fluid content of blood (where the glucose is carried). Abnormalities of haematocrit can result in erroneous blood glucose results. High haematocrit (common in chronic respiratory conditions, high triglycerides, shock or dehydration) can give falsely lower BG readings (less fluid in the blood sample volume), whereas conditions with low haematocrit (e.g. pregnancy) give falsely higher BG results.[22]

Although the ISO standards are important, the skill of the user, not the meter, is the most significant source of BG errors.[23]

Quality assurance (both internal and external) for point-of-care testing by HCPs is mandatory.[24]

Driving and glucose monitoring

Other organisations also have specific recommendations for people living with diabetes. The Driving and Vehicle and Licensing Authority (DVLA) emphasises the responsibilities of drivers when managing their diabetes. This is shown in Table 3.

Table 3: Driving and glucose monitoring.

Who should monitor?
Group 1 drivers who take insulin or sulphonylureas (SUs).
All insulin users must inform the DVLA, as this is mandatory.
Group 2 drivers must advise the DVLA of any diabetes medications taken.
People on SUs should test at times relevant to driving, to enable detection of hypoglycaemia.
Glucose levels should be tested at least 2 hours before driving and every 2 hours on a long journey.
The reading must be >5 mmol/L to drive.
Advise people on an SU or insulin to carry fast-acting carbohydrate and a starchy snack.[25]

Getting the most out of capillary blood glucose monitoring

People with diabetes, HCPs, and professional carers using BG meters should know the individual BG targets and understand what action is required if the result is outside of target range (i.e. the detection and correction of hypoglycaemia and hyperglycaemia).

Other issues to consider are shown in Table 4.

Table 4: Getting the most out of capillary blood glucose monitoring

Correct user technique is critical.
The person performing the test must have received training.
A sharps bin should be close to the individual being tested to reduce the risk of sharps injury.
The individual's hand or finger should be washed and dried before commencing the procedure.
BG testing strips should be in date and should display the date of opening.
Strips should be stored at the correct temperature and in manufacturer's packaging.
The lid should be replaced on the container promptly after removing a strip to keep the contents in the correct condition.
A sufficient blood sample should be obtained (using the side of the finger and an appropriate finger pricking device and technique). The lancet should only be used once and then disposed of safely.
The BG meter should show results in mmol/L not mg/dL.
The user should be aware of the degree of error, especially in the low BG range.
The user should know to re-check if symptoms do not tally with BG reading.
People having abnormalities with haematocrit, haemoglobinopathies or anaemia may experience inaccurate readings.
Only specific meters are suitable for people on peritoneal dialysis, so the HCP needs to check with the manufacturer's' guidance.
Every person who is asked to perform glucose or ketone monitoring should be provided with the correct means of safe disposal of their sharps, i.e. lancets.

Table 5: Who should test and how often?[26]

Type 2 diabetes – Diet and lifestyle management only	HbA1c and frequency of monitoring	Type 1 diabetes – Insulin	HbA1c and frequency of monitoring
Self-monitoring blood glucose (SMBG) is not recommended as part of routine care if HbA1c is within target, but may be useful as an educational tool to understand lifestyle interventions.	Measure HbA1c 3-monthly until target is reached, then monitor 6-monthly.	It is recommended that all people with type 1 diabetes monitor their glucose levels. Glucose levels can be monitored via capillary blood or interstitial fluid. Less frequent monitoring may be acceptable in more stable type 1 diabetes, depending on the person's daily routine.	HbA1c should be measured 3–6 monthly in all people with type 1 diabetes.
Type 2 diabetes – Insulin with/without oral agents	**HbA1c and frequency of monitoring**	**Older people**	**HbA1c and frequency of monitoring**
SMBG is recommended. Regular testing is required at initiation and during adjustment of doses. Frequency may be reduced when glycaemic target reached. Increased testing may be required during intercurrent illness and when there is risk of hypoglycaemia. Adequate training must be provided.	HbA1c should be measured 3-6 monthly. Possible regimens:	Older people and/or carers recently introduced to self-monitoring blood glucose may need support from district nursing teams.	HbA1c should be measured at least every 6 months . The frequency of SMBG will depend on the specific medication prescribed for their diabetes.
Type 2 diabetes – Oral therapy	**HbA1c and frequency of monitoring**	**Diabetes and pregnancy**	**HbA1c and frequency of monitoring**
If HbA1c is out of target or if there is a risk of hypoglycaemia using oral therapies such as sulphonylureas, consider SMBG. The frequency of testing should be agreed with the individual and adequate training provided. Some people benefit from glucose testing for short periods of time, e.g. when oral medication is changed or adjusted or if the individual is on a course of steroid therapy.	Continue to measure HbA1c 3-6 monthly.	Pregnant people with Type 1 should commence CGM. +/- linked technology.[27] Type 2 diabetes and GDM should be offered a connective meter which support remote access for review of clinical data. Type 2 diabetes on multi daily injections of insulin should be considered for CGM Women with diabetes planning for pregnancy or who are pregnant. HbA1c–test pre-conception and in each trimester.	Frequent monitoring throughout the day, concentrating on pre and 2hrs post lunch results.

EMERGING TECHNOLOGIES IN GLUCOSE MONITORING

Glycaemic control can be affected by:[28]

- Persistent hyperglycaemia as measured by HbA1c
- Glycaemic variability between days
- Glycaemic instability within the day.

Reducing hyperglycaemia by improving HbA1c alone may result in hypoglycaemia and can lead to frustration and diabetes burnout for the person living with diabetes. The HbA1c level may result in repeated episodes of undetected hypoglycaemia but does not give information on glycaemic variability. Self-monitoring glucose provides more evidence, but the amount of testing required can be prohibitive and painful.

Continuous glucose monitoring systems and isCGM systems identify variations in glucose levels and enable the person to adjust insulin accordingly.[29]

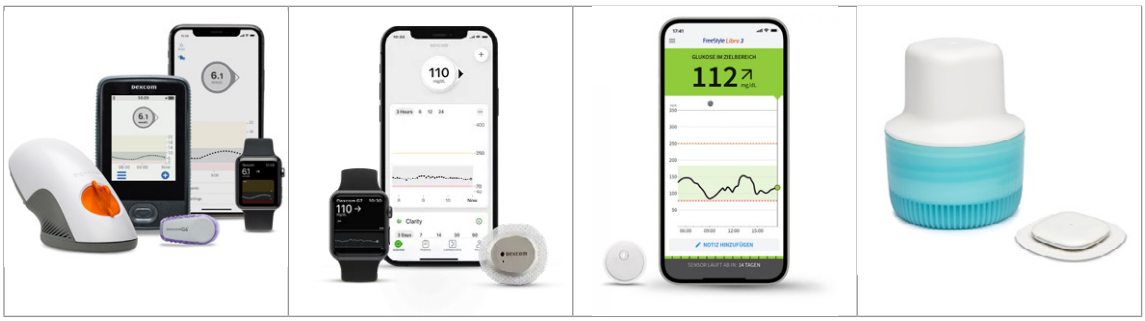
Interpreting the data from these systems can be complex at times so it is important the person using this equipment and their healthcare professionals are familiar with how to interpret the results.

Glucose Monitoring Systems

The sensor has a small filament which is inserted into the interstitial space within the subcutaneous tissue. The sensor includes a transmitter that is attached to the skin, some systems will prompt the user to scan the sensor if glucoses are outside of target range were as others will automatically record glucose data and alert the user of the current glucose levels if target levels have been exceeded. Sensors are usually worn for 10 – 15 days, depending on the product used. It is important to remember there may be a time-lag on the reading of 5-15 minutes depending on the equipment in use and clinical status of the individual.

Please note CGM can be used to supplement capillary glucose testing in hospital but cannot replace it. If a sensor is being used in hospital, at least two capillary blood glucose (CBG) tests should be performed.[28]

Table 6: Examples of CGMS systems available in the UK.



NICE offers specific guidance on the use of continuous glucose monitoring in people with type 1 diabetes.[6]

Adults with type 1 diabetes should be offered a choice of real-time continuous glucose monitoring (rtCGM) or intermittently scanned continuous glucose monitoring (isCGM, commonly referred to as 'flash'), based on their individual preferences, needs, characteristics, and the functionality of the devices available. See box below for examples of factors to consider

Factors to consider when choosing a continuous glucose monitoring device
Accuracy of the device
If the device provides predictive alerts or alarms and if these need to be shared with anyone else (for example, a carer)
If the device requires access to particular technologies (such as a smartphone and up-to-date phone software)
Ease of use to obtain data, including for people with limited dexterity
Fear, frequency, awareness and severity of hypoglycaemia
Psychosocial factors
The person's insulin regimen or type of insulin pump (taking into account whether the particular device integrates with their pump as part of a hybrid closed loop or insulin suspend function)
How often, and how the device needs to be calibrated, is it easy for the person to do this themselves?
How easy is it for the individual to scan the sensor when using isCGM?
How the data is collected. The compatibility of the device with other technology, and if the data can be shared with the person's healthcare provider to help inform treatment
If the device will affect the person's ability to do their job
The impact of the person's activity and glucose levels and whether this impacts on the development of erratic glucose levels and their quality of life
If the person experiences situations when symptoms of hypoglycaemia cannot be communicated or can be confused (for example, during exercise)
If there are clinical factors that may make devices easier or harder to use
The frequency of sensor replacement
If there are sensitivities to the device, for example local skin reactions
Body image concerns

When choosing a continuous glucose monitoring (CGM) device the team should:

- use shared decision making to identify the person's needs and preferences, and offer them an appropriate device
- consider lowest acquisition costs if multiple devices meet their needs and preferences

It is important to note that:

- CGM should be provided by a team with expertise in its use, as part of supporting people to self-manage their diabetes and regular review of CGM usage and care plans reviewed.
- They may still need to take capillary blood glucose measurements (although they can do this less often), as they may need to check the accuracy of their CGM device especially when their blood glucose levels are changing quickly, in illness, if the device stops working or they experience symptoms that do not match the measurement received.
- They must have adequate supply of both blood glucose and blood ketone test strips provided
- CGM training should be provised / included in structured education to support the individual with self management strategies and effective use of therapies
- If a person cannot use or does not want rtCGM or isCGM, offer capillary blood glucose monitoring.
- If there are concerns about the way a person is using the CGM device: ask if they are having problems using the device their device

The advantages and disadvantages when using CGMS are shown in Table 7.

Table 7: Advantages and disadvantages in using CGMS.

Advantages
Alarms
Able to detect glucose variability
Instant access to trends and results
Ability to share results with friends/family/carers
Reduced anxiety
Reduction in need for capillary blood glucose testing
Ability to adjust therapy with access to data including: - 3-5 minute data upload of data collection - Trend arrows - Hypo/hyper avoidance - Smart meter capabilities
Reduction in over treatment of hypoglycaemia and hyperglycaemia
Disadvantages
Some sensors react to paracetamol/ibuprofen
If glucose levels are rising or falling quickly, the accuracy of the sensor reading may be affected
If the individual is unwell, i.e. dehydrated, vomiting or has loose stools, then accuracy can be affected
The individual may develop sensitivities to the adhesive

CGMS, flash glucose monitoring and driving

The DVLA issues guidance twice a year. They have included the use of new technologies in the 2022 guidance.[25]

Recent studies of people with type 1 diabetes support the wider use of flash glucose monitoring to improve outcomes, including improved HbA1c, reduced risk of hypoglycaemia, and improved quality of life.

The DVLA has approved the use of CGMS and flash monitoring for the purposes of Group 1 drivers; it is not legally permitted for Group 2 drivers.

Drivers in the Group 1 category are recommended to carry blood testing equipment in the car. They should test glucose levels using a capillary sample if there is doubt or concern about glucose levels.

See Table 8 for specific DVLA advice.[25]

Table 8: DVLA guidance on CGMS.

Group 1
✔ These systems may be used for monitoring glucose at times relevant to driving. ✔ Users of these systems must carry fingerprick capillary glucose testing equipment for driving purposes as there are times when a confirmatory fingerprick glucose level is required. ✔ If using an interstitial fluid continuous glucose monitoring system (FGM or RT-CGM), the glucose level must be confirmed with a fingerprick glucose reading in the following circumstances: - when the glucose level is 4.0 mmol/L or below - when symptoms of hypoglycaemia are being experienced - when the glucose monitoring system gives a reading that is not consistent with the symptoms being experienced (e.g. where there are symptoms of hypoglycaemia and the system reading does not indicate this) – see INF294 Appendix D, page 125 for further details. - Real-time CGM interstitial fluid glucose monitoring systems are not permitted for the purposes of Group 2 driving and licensing.

Interpretation of readings from systems

Full instruction of data interpretation will be discussed as part of the individuals training when commencing these systems

- The ambulatory glucose profile (AGP) contributes to a systematic approach to interpreting dense glucose data from glucose monitoring systems.
- Consensus recommendations are available to guide the use of the AGP.
- The guidance places emphasis on examination of the AGP for periods of hypoglycaemic risk, i.e. when the 10th centile line for glucose approaches or enters the hypoglycaemic range.
- All the CGM systems have platforms that enable to analysis of glucose data and can be used to identify glucose patterns, median glucose values and a degree of variability of glucose levels.

KETONE MONITORING

Ketone bodies (acetoacetate and β-hydroxybutyrate) are produced in the liver from the breakdown of fatty acids as a source of energy during fasting, exercise and insulin-deficient states, e.g. in intercurrent illness in people with diabetes. The presence of ketones in urine or blood may signify a risk of diabetic ketoacidosis (DKA). This includes any individual with diabetes who presents to a HCP with an acute illness, for example:

- Flu-like symptoms
- Fever
- Cough
- Nausea/vomiting
- Abdominal pain
- Shortness of breath.

In these circumstances, a glucose and urinary or blood ketone test should be undertaken to rule out diabetic ketoacidosis (DKA) or hyperosmolar hyperglycaemic state (HHS).

Diabetic ketoacidosis was considered to be a condition that only affected people with type 1 diabetes, however it is important to note that other precipating factors may increase the risk associated with ketone production. eg. starvation , acute metabolic decompensation, severe hepatic impairment and possibility of some medications increasing the risk of euglycaemic ketoacidosis and other conditions like ketone prone type 2 diabetes which may require additional facilities for ketone monitoring. A survey of the trends and characteristics in the UK using data from the Clinical Practice Research Datalink (CPRD) and Hospital Episode Statistics (HES) from 1998 revealed that 1 in 5 admissions for DKA had occurred in people with type 2 diabetes.[30] Some patients have ketone prone type 2 diabetes who present with ketones but not in DKA but require Insulin therapy and blood ketone monitoring until clinically stable.

People with type 1 diabetes should have access to blood ketone meters as they need to adjust their insulin in alignment with their ketone readings.[6]

There are a variety of blood ketone meters available in the UK, please refer to your local formulary for advice regarding dual blood glucose and ketone testing equipment.

During times of fasting, intercurrent illness or treatment for DKA, conversion of β-hydroxybutyrate to acetoacetate may initially result in a paradoxical rise in ketone bodies. Blood ketone testing provides a more accurate "real time" ketone result. The blood ketone meter ranges are 0 - 8mmol/L:

- NORMAL result = 0.0 - 0.6 mmol/L
- ABNORMAL result = greater than 0.6 mmol/l – the higher the level, the higher risk of DKA

Irrespective of glucose readings or diabetes treatments used, if the individual is acutely unwell the healthcare professional should test or blood ketones.

If the individual is ketotic (> 0.6 mmol/L), consider admission to hospital for assessment:

- At diagnosis of diabetes
- In any person with diabetes who is acutely unwell, irrespective of the glucose level, as part of sick day management
- In people with diabetes with severe nausea/vomiting
- In acidosis and if there is a history of alcohol excess
- When screening for euglycaemic diabetic ketoacidosis, e.g. in people prescribed SGLT2i ('gliflozins').
- **Pregnant women who have diabetes and who are unwell or vomiting irrespective of glucose level should be admitted to hospital for emergency assessment if they have ketones.**[6,31,32]
- **The ketone level determines what action needs to be taken.**

Sick day advice and ketone testing advice for people with type 1 diabetes:

- Increase fluids and take hourly, 100mls/hr but sip slowly. Adjust insulin doses according to ketones (for leaflet click here)
- **Ketone range:**

< 0.6 mmol/L	Is normal
0.6 - 1.5 mmol/L	Means they may be at risk of developing DKA, check medication has been taken, hydrate and test again after two hours. Consider correcting BG levels with rapid acting insulin if they already take this regularly.
1.6 - 2.9 mmol/L	Means they are at risk of DKA and should contact their diabetes team urgently for advice. Encourage the person to hydrate and take correction dose of rapid acting insulin if this is already prescribed
>3 mmol/L	Means they have a very high risk of DKA and should get emergency help as soon as possible. Encourage the person to hydrate and take correction dose of rapid acting insulin if this is already prescribed – and consider 999 call

- If they are only able to do a urine ketone test, a result of 2+ means they may be at risk of developing DKA.
- **If an individual is unable to keep fluids down, admit urgently to hospital.**
- **In pregnancy – if ketotic and/or vomiting or unable to keep fluids down, admit urgently to hospital.**
- **In children with ketosis – admit urgently to hospital.**

Sick day advice and ketone testing advice for people with type 2 diabetes:

- Take sips of fluid hourly
- May initially need to lower or increase insulin or sulphonylureas (for leaflet click here)
- Irrespective of glucose levels or diabetes treatment, if any individual is clinically unwell, test for ketones if glucose >12mmol/l – if positive, consider emergency assessment
- If an individual is on an SGLT-2 inhibitor and or metformin, temporarily stop the drug
- If the individual is taking an ACE inhibitor or ARB, temporarily stop the drug
- If an individual is acutely unwell and ketotic, admit to A&E for assessment

Sharps disposal

Every person who is asked to perform glucose or ketone monitoring should be provided with the correct means of safe disposal of their sharps (i.e. lancets):

- There are a number of devices that enable the safe disposal of used sharps.
- Sharps disposal boxes are available on FP10 prescription.
- Each local council may have a different collection service; this should be clearly communicated to each person with diabetes who is asked to monitor their glucose levels.

The EU Directive 2010/32 became UK law in May 2013; this focuses on the need to provide greater protection to all healthcare workers, downstream workers and others who are at risk of sharps injury.[33] The directive sets out to protect patients and workers at risk by ensuring the safest possible working environment. People with diabetes who are monitoring their own glucose levels at home or whilst they are out and about should be aware of the dangers of disposing of their sharps inappropriately and should be encouraged to use the correct equipment provided.

SUMMARY

There are a variety of methods used to monitor glucose and ketones for people living with diabetes. Testing alone will not lead to improvements in the glycaemic management or safety of these individuals. Effective testing depends on an individual's confidence and competence, and that of their healthcare professionals in using the technology selected; this includes how to adjust lifestyle and medications to improve diabetes control and quality of life.

REFERENCES

1. NHS England (2024) Flash Glucose Monitoring: National arrangements for funding of relevant diabetes patients. Available from: https://www.england.nhs.uk/wp-content/uploads/2020/02/national-arrangements-for-funding-of-relevant-diabetes-patients-v1.2.pdf [Accessed 11th February 2025]
2. Diabetes UK, (2023) www.diabetes.org.uk [Accessed 11th February 2025]
3. Eyth E, Naik R. Hemoglobin A1C. [Updated 2023 Mar 13]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK549816
4. Valenzano M, Cibrario Bertolotti I, Valenzano A, Grassi G. BMJ Open Diabetes Res Care. 2021 Jan;9(1):e001045. doi: 10.1136/bmjdrc-2019-001045. PMID: 33514530; PMCID: PMC7849891.
5. National Institute for Health and Care Excellence. (2008) Continuous subcutaneous insulin infusion for the treatment of diabetes mellitus Technology appraisal guidance. Updated 2011. Available from: https://www.nice.org.uk/guidance/ta151 [Accessed 11th February 2025]
6. National Institute for Health and Care Excellence. (2015b) Type 1 diabetes in adults: diagnosis and management. Updated: 17 August 2022. Available from: https://www.nice.org.uk/guidance/ng17 [Accessed 11th February 2025]
7. Strain WD, Hope SV, Green A, Kar P, Valabhji J, Sinclair AJ. (2018) Type 2 diabetes mellitus in older people: a brief statement of key principles of modern day management including the assessment of frailty. A national collaborative stakeholder initiative. Diabetic Medicine. 35(7), 838-845.
8. American Diabetes Association (2020) Summary of Revisions: Standards of Medical Care in Diabetes—2020. Diabetes Care 43(Supplement 1), S4-S6.
9. Moström P, Ahlén E, Imberg H, Hansson PO, Lind M. Adherence of self-monitoring of blood glucose in persons with type 1 diabetes in Sweden. BMJ Open Diabetes Res Care. 2017 Apr 6;5(1):e000342.
10. Tremolada et al. Health-Related Quality of Life, Family Conflicts and Fear of Injecting: Perception Differences between Preadolescents and Adolescents with Type 1 Diabetes and Their Mothers. Behav Sci (Basel). 2021 Jul 6;11(7):98. doi: 10.3390/bs11070098. PMID: 34356715; PMCID: PMC8301019.
11. DUK 2024 https://www.diabetes.co.uk/emotions/needle-phobia.htm [Accessed 11th February 2025]
12. NICE 2016 Diabetes in children and young people Quality standard [QS125] Published: 14 July 2016 Last updated: 31 March 2022. https://www.nice.org.uk/guidance/qs125/chapter/Quality-statement-6-Access-to-mental-health-professionals-with-an-understanding-of-type-1-or-type-2-diabetes
13. DUK 2024 https://www.diabetes.org.uk/for-professionals/improving-care/good-practice/psychological-care [Accessed 11th February 2025]
14. DCCT (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(14), 977–86.
15. DCCT/EDIC (Diabetes Control and Complications Trial Research Group/ Epidemiology of Diabetes Interventions and Complications). (2005) Intensive Diabetes Treatment and Cardiovascular Disease in patients with type 1 diabetes. New England Journal of Medicine. 353(25), 2643–53.
16. 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.
17. Holman RR, Paul SK, Bethel MA, Matthews DR & Neil HA. (2008) 10-year follow-up of intensive glucose control in type 2 diabetes. New England Journal of Medicine. 359, 1577–89.
18. Stratton IM, Adler AI, Neil HA, Matthews DR, Manley SE, Cull CA, Hadden D, Turner RC & Holman RR. (2000) Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35) prospective
19. Weinstock et al. The Role of Blood Glucose Monitoring in Diabetes Management. Arlington (VA): American Diabetes Association; 2020 Oct. Available from: https://www.ncbi.nlm.nih.gov/books/NBK566165/ doi: 10.2337/db2020-31
20. DUK 2024 https://www.diabetes.co.uk/cost-of-diabetes.html [Accessed 11th February 2025]
21. O'Kane MJ, & Pickup J. (2009). Self-monitoring of blood glucose in diabetes: is it worth it? Annals of clinical biochemistry, 46(Pt 4), 273–282. Available from: https://doi.org/10.1258/acb.2009.009011 [Accessed 11th February 2025]
22. Pham et al (2024), Impact of hematocrit levels on the accuracy of specific blood glucose meters: A hospital-based study. J Diabetes Investig, 15: 1472-1482. https://doi.org/10.1111/jdi.14276
23. Erbach et alInterferences and Limitations in Blood Glucose Self-Testing: An Overview of the Current Knowledge. J Diabetes Sci Technol. 2016 Aug 22;10(5):1161-8. doi: 10.1177/1932296816641433. PMID: 27044519; PMCID: PMC5032951.
24. HM Treasury (2013) Review of quality assurance of Government analytical models: final report. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/206946/review_of_qa_of_govt_analytical_models_final_report_040313.pdf [Accessed 11th February 2025]
25. Driver and Vehicle Licensing Agency (DVLA) (2020) Diabetes mellitus: assessing fitness to drive. Available from: https://www.gov.uk/guidance/diabetes-mellitus-assessing-fitness-to-drive#insulin-treated-diabetes [Accessed 11th February 2025]
26. Amended from Leicester Diabetes Centre and University Hospitals of Leicester NHS Trust (2018) Type 2 Therapies and Management: An Educational Toolkit 3rd Ed. May 2018.
27. National Institute for Health and Care Excellence (2015c) Diabetes in pregnancy: management from preconception to the postnatal period. Last updated: 26 August 2015. Available from: https://www.nice.org.uk/guidance/ng3 [Accessed 11th February 2025]
28. JBDS-IP (2024) Using technology to support diabetes care in hospital: Guidelines from the Joint British Diabetes Societies for Inpatient Care (JBDS-IP) group and Diabetes Technology Network (DTN) UK. Diabet Med. 2024 Oct 21:e15452
29. DSN forum (2024) Real-time Continuous Glucose Monitoring Systems Comparison Chart https://static1.squarespace.com/static/636e507501d1fa72da31dd2d/t/66f06745 34aa591894 8b2949/1727031109799/CGM+chart+V8+Sept2024.pdf [Accessed 11th February 2025]
30. Zhong VW, Juhaeri J, Mayer-Davis EJ. (2018) Trends in hospital admission for diabetic ketoacidosis in adults with type 1 and type 2 diabetes in England, 1998–2013: a retrospective cohort study. Diabetes Care 2018;41:1870–1877 pmid:2938624
31. NHS England Regional Medicines Optimisation Committee. (2017) Flash Glucose Monitoring Systems. Position Statement. Available from: https://www.sps.nhs.uk/wp-content/uploads/2017/11/Flash-Glucose-monitoring-System-RMOC-Statement-final-2.pdf [Accessed 11th February 2025]
32. Dover AR, Stimson RH, Zammitt NN, Gibb FW. Flash Glucose Monitoring Improves Outcomes in a Type 1 Diabetes Clinic. Journal of Diabetes Science and Technology 2017;11(2):442 –443. Available from: https://journals.sagepub.com/doi/pdf/10.1177/1932296816661560
33. European Union (2017) Directive 2010/32/EU - prevention from sharp injuries in the hospital and healthcare sector. Latest update: 04/10/2017. Available from: https://osha.europa.eu/en/legislation/directives/council-directive-2010-32-eu-prevention-from-sharp-injuries-in-the-hospital-and-healthcare-sector [Accessed 11th February 2025]

t·r·e·n·d™ DIABETES

™ Trend Diabetes Limited. Content to be reviewed March 2027

info@trenddiabetes.online www.trenddiabetes.online @TrendDiabetes

March 2025