

Diabetes, Painless Glucose Testing and More

Haywards Heath & District Probus Club



What is Diabetes?

Diabetes is a complicated and serious condition of which there are many different types. This paper provides an overview of the condition with details of needle-free blood sugar monitoring. Diabetes prevents your body from converting sugars and starches in your food into energy. The body uses insulin to do this. A diabetic person's blood glucose level is often too high because the body doesn't produce enough insulin. It can lead to complications that significantly impact the quality of life and health, including increased risk of heart attack and stroke.

The World Health Organization, [HERE](#), says this about diabetes:

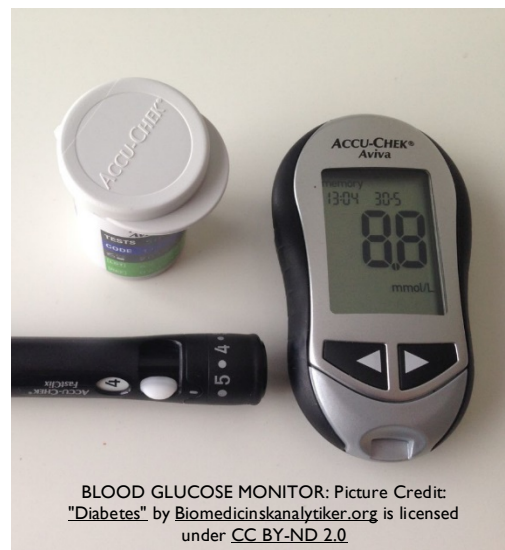
Diabetes is a chronic, metabolic disease characterised by elevated levels of blood glucose (or blood sugar), which leads over time to serious damage to the heart, blood vessels, eyes, kidneys and nerves. The most common is type 2 diabetes, usually in adults, which occurs when the body becomes resistant to insulin or doesn't make enough insulin. In the past three decades, the prevalence of type 2 diabetes has risen dramatically in countries of all income levels. Type 1 diabetes, once known as juvenile diabetes or insulin-dependent diabetes, is a chronic condition in which the pancreas produces little or no insulin by itself. For people living with diabetes, access to affordable treatment, including insulin, is critical to their survival. There is a globally agreed target to halt the rise in diabetes and obesity by 2025.

According to the [European Society of Cardiology](#), over 460 million people worldwide have diabetes, the majority living in low-and middle-income countries, and 4.2 million deaths are directly attributed to diabetes each year. Both the number of cases and the prevalence of diabetes have been steadily increasing over the past few decades. The [Diabetes Research & Wellness Foundation](#) say that there are currently more than 3.8 million people with diabetes in the UK. It is estimated that a further 500,000 adults have type 2 diabetes but don't know it. Currently, the treatment and care of diabetes and its related conditions use around 10% of the annual NHS spend, approximately £10 billion per year.

Types of Diabetes

As mentioned above, the two main types of diabetes are type 1 and type 2: different conditions, but they're both serious.

- With **type 1 diabetes**, you can't make any insulin at all. The cause of type 1 diabetes is unknown, but it is thought to be an auto-immune process. In effect, the body produces antibodies to the pancreas - damaging it and preventing it from producing insulin. Type 1 diabetes only affects about 10% of all people with diabetes, and it usually starts below the age of 40.
- If you've got **type 2 diabetes**, the insulin you make either can't work effectively, or you can't produce enough of it. Type 2 diabetes is more likely to affect older people, although it is being found increasingly in younger people - especially if they are overweight and lack physical activity. Type 2 diabetes is strongly linked to obesity and tends to run in families.
- Other types of diabetes include **gestational diabetes**, which some women may go on to develop during pregnancy. And there are many other **rarer types of diabetes**, such as **type 3c** and **Latent Autoimmune Diabetes in Adults (LADA)**.

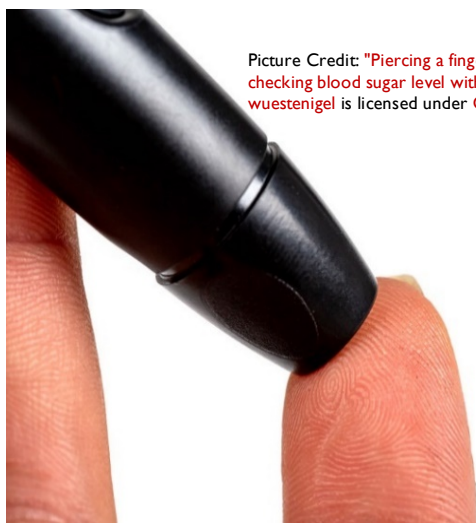


BLOOD GLUCOSE MONITOR: Picture Credit: "Diabetes" by Biomedizinskanalytiker.org is licensed under CC BY-ND 2.0

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Picture Credit: "Piercing a finger, close up. Person's hand checking blood sugar level with glucometer" by wuestenigel is licensed under CC BY 2.0

A rare condition called *diabetes insipidus* is not related to diabetes mellitus (the Latin name for diabetes), although it has a similar name. It's a different condition in which your kidneys remove too much fluid from your body.

In all types of diabetes, glucose can't get into your cells properly, so it begins to build up in your blood. And too much glucose in your blood causes a lot of different problems. Untreated high blood sugar from diabetes can damage your nerves, eyes, kidneys, and other organs.

Sources: <https://www.diabetes.org.uk/diabetes-the-basics> and <https://www.drwf.org.uk/understanding-diabetes>

Glucose Levels

If a person with diabetes is testing for glucose levels, it's essential to know what the blood glucose level means. Recommended blood glucose levels have a degree of interpretation for every individual and should be discussed with the healthcare team. In addition, women may be set target blood sugar levels during pregnancy.

The following ranges are guidelines provided by the National Institute for Clinical Excellence (NICE), but each individual's target range should be agreed with their doctor or diabetic consultant. The NICE recommended target blood glucose levels are stated below for adults with type 1 diabetes, type 2 diabetes and children with type 1 diabetes. The table provides general guidance. The individual target set by your healthcare team is the one that should be aimed for.

NICE recommended target blood glucose level range

Target Levels by Type	Upon waking	Before meals	At least 90 minutes after meals
Type 2 diabetes		4 to 7 mmol/L	under 8.5 mmol/L
Type 1 diabetes	5 to 7 mmol/L	4 to 7 mmol/L	5 to 9 mmol/L
Children with type 1 diabetes	4 to 7 mmol/L	4 to 7 mmol/L	5 to 9 mmol/L

Normal and diabetic blood sugar ranges

For the majority of healthy individuals, normal blood sugar levels are as follows:

- **Between** 4.0 to 5.4 mmol/L (72 to 99 mg/dL) when fasting
- **Up to** 7.8 mmol/L (140 mg/dL) 2 hours after eating

For people with diabetes, blood sugar level targets are as follows:

- **Before meals:** 4 to 7 mmol/L for people with type 1 or type 2 diabetes
- **After meals:** under 9 mmol/L for people with type 1 diabetes and under 8.5mmol/L for people with type 2 diabetes

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Needle-Free Diabetes Care

Including excerpts from an article by Clara Rodríguez Fernández at: <https://www.labiotech.eu/best-biotech/blood-sugar-monitor-diabetes/>

People with diabetes, who take insulin to regulate blood sugar, need to test their glucose levels several times daily (see picture above). At first, these finger pricks with a lancet may not be painful or uncomfortable, but over time that can change. It may result in less frequent testing and consequently worsening control of blood sugar levels.

Now, the daily routine of finger pricking may have come to an end with the influx to the market of 'smart' devices that painlessly monitor blood sugar. Many companies worldwide aim to make the lives of millions of people with diabetes better by developing non-invasive glucose monitoring methods.

Non-invasive continuous glucose meters (CGMs) are considered convenient and effective, although they may not be as accurate as traditional meters. A CGM is a type of meter that doesn't require a blood sample. Most CGMs detect glucose through interstitial fluids in skin tissues. Some CGMs have the capability of connecting to and **downloading blood glucose information to your smartwatch**. But thus far, no smartwatch can directly measure your blood sugar.

UK Diabetes.org.uk

The UK Diabetes.org.uk charity says (**HERE**) that a CGM doesn't actually measure your blood glucose levels - it measures the amount of glucose in the fluid that surrounds your body cells – called interstitial fluid. There is a short time delay when checking this fluid, especially after eating or if you're exercising. So your CGM result isn't always precisely the same as your finger-prick result. This means you'll still need to do a finger-prick test if you're thinking of changing your treatment at any point: for example, if you need to take more insulin or if you're treating a hypo, so you can get the most accurate result.

A CGM has three parts:

- A sensor that sits just underneath your skin and measures your sugar levels.
- A transmitter that's attached to the sensor and sends your levels to your display device.
- A display device that shows you your sugar level. This might be a separate handheld device (known as "standalone" CGM) or a pump (known as an "integrated system").

CGM comes with software to analyse your results and see patterns in your sugar levels over time. You generally wear a sensor for up to seven days, and after that, you need to replace it. When you change your sensor, you reattach the transmitter to your new sensor. You need to calibrate a CGM by checking your finger-prick blood glucose levels, generally twice a day.

What Needle-Free Options are there?

The number of needle-free options available is increasing all the time. It is best to speak to your GP or diabetic specialist about which option might be best for you. Some of the options available today are:

FreeStyle Libre

One of the best new products is FreeStyle Libre, developed by *Abbott Diabetes Care* in the US, which measures glucose levels in the interstitial fluid between the cells right under the skin. The FreeStyle Libre system is a **continuous glucose monitor** (CGM) worn on the upper arm that provides real-time blood glucose (blood sugar) readings every minute for people who have type 1 diabetes or type 2 diabetes, especially those who take insulin.

The Freestyle Libre systems you can choose from are:

- The original Freestyle Libre 14-day system (approved for adults 18 and older).
- The Freestyle Libre 2 system (approved for adults and children age four and older).

See: <https://www.verywellhealth.com/freestyle-libre-a-glucose-meter-without-a-finger-prick-4154266> and <https://www.freestylelibre.co.uk/libre/>



NEEDLE-FREE GLUCOSE MONITOR; Picture Credit: "7018109.11 Continuous Glucose Monitoring, Washington, DC USA, 1287" by tedeytan is licensed under CC BY-SA 2.0

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[DiaMonTech](#)

The German firm *DiaMonTech* has developed a family of solutions: A desktop device for clinical settings and multiple users (D-Base), a compact pocket device for the end-user (D-Pocket) and a watch-like device you can wear on your wrist that measures your glucose levels continuously (D-Sensor). Each device can also communicate with your mobile phone, so you can check your information at any time and take immediate action. Measurement of blood sugar levels is achieved by beaming an infrared laser through the skin of a finger and causing glucose in the skin to convert the light to heat. The machine then calculates the glucose levels based on how much the skin's heat increases, although the temperature rise is too small to be noticed by the user. For further information, visit <https://www.diamontech.de/home>.

[Eversense](#)

Developed by the US company *Senseonics*, Eversense is a subcutaneous (under the skin) implant that continuously monitors blood glucose levels. Although it initially needs to be installed under the skin by a doctor, the sensor can last for up to three months before needing a replacement. Eversense measures glucose in the interstitial fluid under the skin of the upper arm by using a polymer that fluoresces in response to the levels of blood sugar. The data is then sent to a transmitter that displays the blood glucose levels in real-time. For further information, visit <https://www.ascensiadiabetes.com/eversense/eversense-cgm-system/>.

[Dexcom](#)

The Dexcom G6 is a one-touch applicator that easily inserts a small sensor just beneath the skin. The sensor continuously measures glucose levels just beneath the skin and sends data wirelessly to a display device through a transmitter. The customisable high and low alerts help you keep in range; the fixed Urgent Low alarm tells you when your blood sugar level is dangerously low, and a unique predictive warning can warn you up to 20 minutes before a serious low - so you can take action to avoid it. The display device is an Apple or Android compatible smart device or touch screen receiver that displays real-time glucose data. For further details and buying options, visit <https://www.dexcom.com/en-GB/thedifference-info>.

[GlucoTrack](#)

Developed by the US-Israeli company *Integrity Applications*, GlucoTrack can monitor blood sugar levels through a combination of ultrasonic, electromagnetic, and thermal waves. GlucoTrack® DF-F includes a Main Unit, which has a big colour touch screen with large digits, audible results and a Personal Ear Clip, which is clipped to the earlobe and contains sensors to measure glucose levels in the tissue. The device is small, light, easy to use and handle. The device is indicated for adults with type 2 diabetes and is marketed in Europe. For further details and buying options, visit <http://www.glucotrack.com/>.

Blood Lows and Highs

Counting carbohydrates every time you eat is a vital part of maintaining normal blood glucose levels. It helps people with diabetes determine how much insulin to take. It's a juggling act to take enough but not too much insulin to ensure that no lows or highs occur.

[Lows](#)

Low blood sugar (*hypoglycaemia*, or 'hypo') is when your blood sugar drops too low. A low blood sugar level can be dangerous if it's not treated quickly. Low blood sugar can be caused by taking too much insulin, not having sufficient carbohydrates with the last meal, skipping meals or intense exercise.

Signs of low blood sugar include trembling, tingling lips, sweating, feeling tired, dizziness, feeling hungry, a fast or pounding heartbeat (palpitations), becoming irritated easily, being tearful, anxious or moody, or turning pale. These warning signs are the body's way of telling you that there is a problem. A series of hypos over a short period may cause the body to switch off these warning signs until equilibrium returns.

To best treat low blood sugar, the general solution is to have some sweets or a non-diet sugary drink, followed by carbohydrate as a snack, like toast or a main meal.

If you keep getting a low blood sugar level, it is recommended that you talk to your diabetes care team about things you can do to help prevent it. For further information, visit <https://www.nhs.uk/conditions/low-blood-sugar-hypoglycaemia/#overview>.

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Highs

Hyperglycaemia is the medical term for a high blood sugar (glucose) level. It's a common problem for people with diabetes. It can affect people with type 1 diabetes and type 2 diabetes, and pregnant women with gestational diabetes. It can occasionally affect people who do not have diabetes, but usually only seriously ill people, such as those who have recently had a stroke or heart attack or have a severe infection.

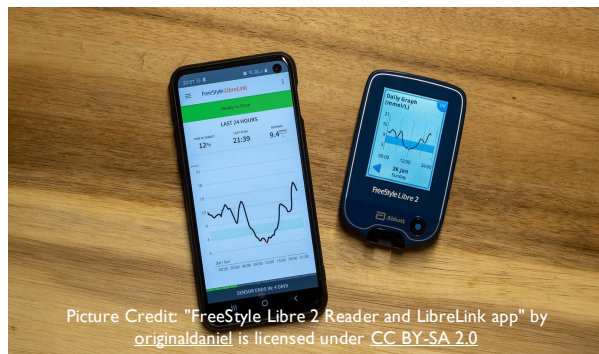
The aim of glucose control is to keep blood sugar levels as near to normal as possible. But if you have diabetes, no matter how careful you are, you're likely to experience hyperglycaemia at some point. It's important to recognise and treat hyperglycaemia, as it can lead to serious health and life-threatening problems if left untreated:

- Occasional mild episodes are not usually a cause for concern and can be treated quite easily or may return to normal on their own.
- Hyperglycaemia can be potentially dangerous if blood sugar levels become very high or stay high for long periods.

For further information, visit <https://www.nhs.uk/conditions/high-blood-sugar-hyperglycaemia/>.

Further Useful Information about Diabetes

- <https://preventing-diabetes.co.uk/know-your-risk-dtc/>
- <https://www.diabetes.org.uk/diabetes-the-basics>
- <https://www.hriuk.org/what-is-diabetes>
- <https://www.healthline.com/health/diabetes/blood-sugar-monitor-without-finger-pricks#fa-qs-on-cg-ms>
- <https://www.nhs.uk/conditions/diabetes/>



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