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Patient education: Self-monitoring of blood sugar in diabetes (Beyond the Basics)

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BLOOD SUGAR TESTING OVERVIEW

If you have diabetes, you have an important role in your own medical care, and monitoring your blood sugar (glucose) level is a key part of this.

Although diabetes is a chronic condition, it can usually be controlled with lifestyle changes, medication, and self-care measures. The main goal of diabetes treatment is to keep your blood sugar levels in the target range. Checking your blood sugar is one of the best ways to know how well your diabetes treatment plan is working. Blood sugar can be tested with fingersticks and a glucose meter, or with a continuous glucose monitoring (CGM) device, if available. The use of CGM devices has been increasing, especially for people who use an insulin pump or multiple daily insulin injections. (See '[Testing blood sugar with fingersticks and a glucose meter](#)' below and '[Continuous glucose monitoring](#)' below.)

Your health care provider will periodically order a blood test to check your current blood sugar levels and glycated hemoglobin (A1C). The A1C test gives an overall sense of how blood sugar levels are controlled since it measures your **average** blood sugar level of the past two to three months ([table 1](#)). However, in order to most effectively manage your diabetes and adjust your treatment approach as

needed, you will also need to check your own blood sugar levels on a daily basis. The exact schedule you will follow depends on several different factors. (See ['Frequency of blood sugar testing'](#) below.)

FREQUENCY OF BLOOD SUGAR TESTING

Studies have proven that people with diabetes who maintain normal or near-normal blood sugar levels reduce their risk of diabetes-related complications. (See ["Patient education: Preventing complications from diabetes \(Beyond the Basics\)"](#).)

How often you need to check your blood sugar will depend upon the type of diabetes you have (type 1 or 2), which treatment(s) you use (oral medications, insulin, and/or lifestyle changes), and your treatment goals.

Type 1 diabetes — For people with type 1 diabetes, frequent testing is the only way to safely and effectively manage blood sugar levels. (See ["Patient education: Type 1 diabetes: Overview \(Beyond the Basics\)"](#).)

Most people need to test at least four times per day. If you use an insulin pump, give yourself three or more insulin injections per day, or are a woman with type 1 diabetes who is pregnant, you may need to test as many as 10 times per day or more. (See ["Patient education: Care during pregnancy for women with type 1 or 2 diabetes \(Beyond the Basics\)"](#).)

People who test frequently, especially those using intensive insulin therapy (ie, multiple doses of insulin per day or an insulin pump), may consider continuous glucose monitoring (CGM) (see ['Continuous glucose monitoring'](#) below). If you don't use CGM, you may want to purchase several blood glucose meters to keep at home, work, school, and/or in a purse or backpack. This way you will be able to access your testing equipment wherever you are, making it easier to keep your blood sugar under control.

Type 2 diabetes — For people with type 2 diabetes, the recommendations for how often to test blood sugar are based upon individual factors such as type of treatment (oral medications, insulin, and/or lifestyle changes), A1C level, risk of hypoglycemia (when blood sugar is too low), and treatment goals.

Blood sugar monitoring is useful for people with type 2 diabetes who take insulin or certain medications that can cause hypoglycemia. It is generally unnecessary in people who manage their diabetes with diet alone or who take medications that do not cause hypoglycemia. Your health care provider can help you determine how frequently to check your blood sugar based on your situation. (See ["Patient education: Type 2 diabetes: Overview \(Beyond the Basics\)"](#).)

TESTING BLOOD SUGAR WITH FINGERSTICKS AND A GLUCOSE METER

How to check your blood sugar — The following steps include general guidelines for testing blood sugar levels. However, because the instructions can vary between devices, it's best to check the package insert for your glucose meter or talk with your health care provider. It's important to never share monitoring equipment or fingerstick devices, as this could lead to infection.

- Wash hands with soap and warm water, then dry.
- Prepare the lancing device by inserting a fresh lancet. Lancets that are used more than once are not as sharp as a new lancet and can cause more pain and injury to the skin.
- Prepare the blood glucose meter and test strip (the exact instructions for this depend upon the type of glucose meter used).
- Use the lancing device to obtain a small drop of blood from your fingertip ([picture 1](#)) or alternate site (like the skin of the forearm) ([picture 2](#)). Alternate sites are often less painful than the fingertip. However, results from alternate sites are not as accurate as fingertip samples. This should not be a problem if you always use the same site. However, when your blood sugar is rising rapidly (eg, immediately after eating) or falling rapidly (in response to insulin or exercise), it's more accurate to use the fingertip, as testing at alternate sites may give significantly different results in these situations.

If you have difficulty getting a good drop of blood from your fingertip, try rinsing your fingers with warm water and shaking your hand below your waist. This can help get the blood flowing.

- Apply the blood drop to the test strip in the blood glucose meter. The results will be displayed on the meter after several seconds.
- Dispose of the used lancet in a container designed for sharps (not in household trash).

Blood glucose meters — There is no single blood glucose meter that is better than others. Your health care provider or pharmacist can help you choose a meter based on your preferences as well as other factors like cost, ease of use, and accuracy; it should be one that is approved by either the International Organization for Standardization or the US Food and Drug Administration. Many insurance providers cover the cost of specific meters and/or supplies. Medicare also covers costs of blood glucose monitoring.

Accuracy of home blood sugar monitoring — Blood glucose meters are reasonably accurate. However, there can be some variability between meters, so it is always wise to use caution and common sense. If you get a result that does not fit with how you feel (for example, if it says your

blood sugar is very low but you don't have any symptoms), take a second reading or use an alternate method for testing your blood sugar (such as a different meter). Blood glucose meters are least accurate during episodes of low blood sugar. (See ["Patient education: Hypoglycemia \(low blood sugar\) in diabetes mellitus \(Beyond the Basics\)".](#))

The accuracy of blood glucose monitoring can be affected by several factors, including the type of blood glucose strip and meter. It's a good idea to check the accuracy of your blood glucose meter occasionally by bringing it with you when you have an appointment to get blood testing. This way, you use your home monitor to check your blood sugar at the same time that blood is drawn and compare the results. If the results differ by more than 15 percent, there may be a problem with your meter or other equipment; your provider can help you figure out what's going on and how to correct the problem.

Help for people with vision impairment — People with vision impairment (a common complication of diabetes) sometimes have difficulty using glucose meters. Meters with large screens and "talking" meters are available. If you have impaired vision, you can get help from the American Association of Diabetes Educators (AADE) at (800) 338-3633.

CONTINUOUS GLUCOSE MONITORING

Continuous glucose monitoring (CGM) is a way to monitor your blood sugar levels every 5 to 15 minutes, 24 hours a day. Because of reliability issues and the need to calibrate some of the devices, CGM does not eliminate the need for at least occasional fingersticks.

CGM systems use a glucose sensor to measure the level of glucose in the fluid under the skin. The sensor is attached to a transmitter placed on your skin, which is held in place with a sticky patch. It wirelessly transmits results to a small recording device (no larger than a cell phone) or to a smartphone or other smart device. In some cases, it transmits the information directly to an insulin pump. You can attach the recording device to your clothing, carry in a purse or bag, or place it near you (eg, on a bedside table).

If you use a CGM system, you will need to remove the sensor and replace it on a different part of your body approximately once every 7 to 14 days. Different CGM systems are available; one implantable sensor can last up to 90 days, but needs to be inserted and removed by a physician, nurse practitioner, or physician assistant.

CGM systems are most often used by people with type 1 diabetes who give themselves multiple daily insulin injections or use an insulin pump. Devices that combine an insulin pump with a CGM system are also available (see ["Patient education: Type 1 diabetes: Insulin treatment \(Beyond the Basics\)".](#))

Many experts think that CGM may be most useful in people who have frequent episodes of low blood sugar, episodes of low blood sugar during the night ("nocturnal hypoglycemia"), large fluctuations in their blood sugar levels, and/or difficulty recognizing when they have low blood sugar.

Intermittent use of CGM may also be appropriate for some people with type 2 diabetes who need multiple daily insulin injections, particularly those with frequent episodes of low blood sugar or difficulty recognizing when they have low blood sugar. Intermittent use of CGM can help you and your doctor determine when the blood sugar is low and high and how to adjust your insulin dose (or food intake) to prevent it.

Advantages — There is evidence that people with type 1 diabetes who use a CGM system consistently and reliably (rather than the fingerstick method) have modestly better-controlled blood sugar.

The "real-time" CGM devices automatically display your blood sugar level every five minutes, using numbers, graphics, and arrows so you can easily tell if your level is increasing, decreasing, or stable. The receiver (recording device) can also be set to trigger an alarm if your blood sugar level gets above or below a preset level, which can be especially helpful for people who cannot feel when they have low blood glucose (also known as "hypoglycemia unawareness"). The less expensive "intermittently scanned" or "flash" CGM devices record your blood sugar every 15 minutes and display glucose trends, but to view these results you have to scan the sensor/transmitter with the reader/receiver. These intermittently scanning CGM devices are not able to alert you of low or high blood sugar readings.

You can download blood sugar results from the CGM system to your computer or smartphone, allowing you to see blood sugar trends over time. If you take insulin, your health care provider can help you figure out how to use this information to adjust your insulin dose if needed.

Drawbacks — The continuous glucose sensors may show lower glucose values than blood glucose meters, especially when blood glucose levels are rapidly rising. CGM systems also tend to be less accurate when blood sugar is low (<40 mg/dL or 2.2 mmol/L) and therefore may not be able to reliably indicate when this is happening. With many CGM systems, you will still need to check your blood sugar using a fingerstick at least occasionally, to calibrate some of the devices and/or to confirm a blood sugar reading before insulin dosing.

In addition, the costs associated with CGMs are much greater than those of traditional glucose meters. Not all continuous glucose meters and supplies are covered by commercial health insurance companies.

INTERPRETING BLOOD SUGAR RESULTS

Blood sugar testing — The results of blood sugar testing tell you how well your diabetes treatments are working. However, blood sugar results can be affected by different things, including your level of physical activity, what you eat, stress, and medications (including insulin and oral diabetes medications). To fully understand what your blood sugar levels mean, it is important to consider all of these factors.

When keeping track of your results, you should include the time and date, blood glucose result, and the medication and dose you are taking. Additional notes about what you ate, whether you exercised, and any difficulties with illness or stress can also be helpful but are not generally required every day. You should review this information regularly with your health care provider to understand what your results mean and whether you need to make any changes to better manage your blood sugar.

Need for urine testing — If you have type 1 diabetes, your health care provider will talk to you about checking your urine for ketones. You will need to do this if your blood sugar level gets above 250 to 300 mg/dL (13.9 to 16.7 mmol/L), during periods of illness or stress, or if you have symptoms of a problems called ketoacidosis (such as nausea, vomiting, and abdominal pain).

Ketones are acids that are formed when the body does not have enough insulin to get glucose into the cells, causing the body to break down fat for energy. Ketones can also develop during illness, if an inadequate amount of glucose is available (due to skipped meals or vomiting). Ketoacidosis is a condition that occurs when high levels of ketones are present in the body; it can lead to serious complications such as diabetic coma.

Urine ketone testing is done with a dipstick, available in pharmacies without a prescription. If you have moderate to large ketones, you should call your health care provider immediately to determine the best treatment. You may need to take an additional dose of insulin, or your provider may instruct you to go to the nearest emergency room. Meters that measure ketone levels in the blood are also available, but due to their cost, urine testing is more widely used.

ADJUSTING TREATMENT

Home blood sugar monitoring or continuous glucose monitoring (CGM) provides useful information and is an important part of managing your diabetes. If you use insulin, your blood sugar results will help guide you in choosing the appropriate doses from meal to meal. When you first start treatment for diabetes, you will need to work with your health care provider as you learn to make adjustments in

treatment. However, with time and experience, most people are able to learn how to make adjustments on their own.

WHERE TO GET MORE INFORMATION

Your health care provider is the best source of information for questions and concerns related to your medical problem.

This article will be updated as needed on our website (www.uptodate.com/patients). Related topics for patients, as well as selected articles written for health care professionals, are also available. Some of the most relevant are listed below.

Patient level information — UpToDate offers two types of patient education materials.

The Basics — The Basics patient education pieces answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials.

[Patient education: Type 2 diabetes \(The Basics\)](#)

[Patient education: Using insulin \(The Basics\)](#)

[Patient education: Treatment for type 2 diabetes \(The Basics\)](#)

[Patient education: Low blood sugar in people with diabetes \(The Basics\)](#)

[Patient education: Care during pregnancy for women with type 1 or type 2 diabetes \(The Basics\)](#)

[Patient education: My child has diabetes: How will we manage? \(The Basics\)](#)

[Patient education: Controlling blood sugar in children with diabetes \(The Basics\)](#)

[Patient education: Managing diabetes in school \(The Basics\)](#)

[Patient education: Hemoglobin A1C tests \(The Basics\)](#)

[Patient education: Giving your child insulin \(The Basics\)](#)

[Patient education: Checking your child's blood sugar level \(The Basics\)](#)

[Patient education: Diabetic ketoacidosis \(The Basics\)](#)

[Patient education: Hyperosmolar nonketotic coma \(The Basics\)](#)

[Patient education: Diabetes and infections \(The Basics\)](#)

Beyond the Basics — Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are best for patients who want in-depth information and are comfortable with some medical jargon.

[Patient education: Type 1 diabetes: Overview \(Beyond the Basics\)](#)

[Patient education: Care during pregnancy for women with type 1 or 2 diabetes \(Beyond the Basics\)](#)

[Patient education: Type 2 diabetes: Overview \(Beyond the Basics\)](#)

Professional level information — Professional level articles are designed to keep doctors and other health professionals up-to-date on the latest medical findings. These articles are thorough, long, and complex, and they contain multiple references to the research on which they are based. Professional level articles are best for people who are comfortable with a lot of medical terminology and who want to read the same materials their doctors are reading.

[Self-monitoring of glucose in management of nonpregnant adults with diabetes mellitus](#)

[Estimation of blood glucose control in diabetes mellitus](#)

[Management of type 1 diabetes mellitus in children and adolescents](#)

[Treatment of type 2 diabetes mellitus in the older patient](#)

The following organizations also provide reliable health information.

- National Library of Medicine

(www.nlm.nih.gov/medlineplus/healthtopics.html)

- National Institute of Diabetes and Digestive and Kidney Diseases

(www.niddk.nih.gov/)

- American Diabetes Association (ADA)

(800)-DIABETES (800-342-2383)

(www.diabetes.org)

- Hormone Health Network

(www.hormone.org, available in English and Spanish)

[1-4]

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Topic 1744 Version 17.0

GRAPHICS

A1C level and average blood sugar

If your A1C level is (percent):	That means your average blood sugar level during the past two to three months was approximately:	
	If you live <i>within the United States</i> , use these values. Your blood sugar is measured in milligrams/deciliter (mg/dL).	If you live <i>outside the United States</i> , use these values. Your blood sugar is measured in millimoles/liter (mmol/L).
5	97	5.4
6	126	7
7	154	8.6
8	183	10.2
9	212	11.8
10	240	13.3
11	269	15
12	298	16.5
13	326	18.1
14	355	19.7

The A1C blood test tells you what your average blood sugar level has been for the past two to three months. This table lists which A1C levels go with which average blood sugar levels. Blood sugar is measured differently within the United States than it is in most other countries. The column in the middle is for people in the United States. The column on the right is for people who live outside the United States.

A1C: glycated hemoglobin.

Graphic 76310 Version 4.0

Fingertip testing



The sides of the fingers have fewer nerve endings than the middle of the fingertips. It might not hurt as much to use the sides of your fingers to test your blood sugar.

Graphic 57918 Version 3.0

Other places to test your blood sugar



This photo shows how you can test your blood sugar in places other than your fingertips. You might need to gently massage the skin to get a large enough drop of blood. Do not use other places if you think your blood sugar is low.

Graphic 63375 Version 2.0

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