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Hemoglobin A1c

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Also known as: A1c; HbA1c; Glycohemoglobin; Glycated Hemoglobin; Glycosylated Hemoglobin

Formal name: Hemoglobin A1c

Related tests: [Glucose Tests](#); [Urine Albumin](#); [Urine Albumin/Creatinine Ratio](#); [Fructosamine](#)



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At a Glance

Why Get Tested?

To help identify those at an increased risk of developing [diabetes](#) and to help diagnose diabetes; to monitor a person's diabetes and to aid in treatment decisions

When to Get Tested?

As part of a health checkup or when you have risk factors for or symptoms of diabetes; after first diagnosis with diabetes, 4 times per year if glycemic goals are not met or when therapy plan has changed; at least 2 times a year if meeting treatment goals and under stable glycemic control

Sample Required?

A blood sample drawn from a vein in your arm or from a fingerstick

Test Preparation Needed?

None

The Test Sample

What is being tested?

Hemoglobin A1c, also called A1c or glycated hemoglobin, is hemoglobin with glucose attached. The A1c test evaluates the average amount of glucose in the blood over the last 2 to 3 months by measuring the percentage of glycated (glycosylated) hemoglobin.

Hemoglobin is an oxygen-transporting [protein](#) found inside red blood cells (RBCs). There are several types of normal hemoglobin, but the predominant form – about 95-98% – is hemoglobin A. As glucose circulates in the blood, some of it spontaneously binds to hemoglobin A.

The higher the level of glucose in the blood, the more glycated hemoglobin is formed. Once the glucose binds to the hemoglobin, it remains there for the life of the red blood cell – normally about 120 days. The predominant form of glycated hemoglobin is referred to as A1c. A1c is produced on a daily basis and slowly cleared from the blood as older RBCs die and younger RBCs (with non-glycated hemoglobin) take their place.

This test may be used to screen for and diagnose [diabetes](#) or risk of developing diabetes. Standards of medical care in diabetes from the American Diabetes Association (ADA) state that diabetes may be diagnosed based on A1c criteria or [plasma glucose](#) criteria, either the fasting plasma glucose (FPG) or the 2-hour plasma glucose value after a 75-g oral glucose tolerance test (OGTT).

This test is also used to monitor treatment for someone who has been diagnosed with diabetes. It helps to evaluate how well the person's glucose levels have been controlled by treatment over time. For monitoring purposes, an A1c of less than 7% indicates good glucose control and a lower risk of diabetic complications for the majority of diabetics.

However, the ADA and the European Association for the Study of Diabetes (EASD) recommend that the management of glucose control in [type 2 diabetes](#) be more "patient-centered." Data from recent studies have shown that low blood sugar ([hypoglycemia](#)) can cause complications and that people with risk of severe hypoglycemia, disease duration, underlying health conditions, established vascular complications, and a limited life expectancy do not necessarily benefit from having a stringent goal of less than 7% for their A1c. It is recommended that people work closely with their healthcare provider to select a goal that reflects each person's individual health status and that balances risks and benefits.

How is the sample collected for testing?

A blood sample is obtained by inserting a needle into a vein in the arm or a drop of blood is taken from a finger by pricking it with a small, pointed lancet.

Is any test preparation needed to ensure the quality of the sample?

No test preparation is needed.

The Test

How is it used?

Screening and diagnosis

The hemoglobin A1c test may be used to screen for and diagnose **diabetes** and prediabetes in adults. Hemoglobin A1c, also glycated hemoglobin or A1c, is formed in the blood when glucose attaches to hemoglobin. The higher the level of glucose in the blood, the more glycated hemoglobin is formed. (Read more in the "**What is being tested?**" section.)

The A1c test, however, should not be used for screening for **cystic fibrosis**-related diabetes, for diagnosis of **gestational diabetes** in pregnant women, or for diagnosis of diabetes in children and adolescence, people who have had recent severe bleeding or blood transfusions, those with chronic **kidney** or **liver disease**, or people with blood disorders such as **iron-deficiency anemia**, **vitamin B12 deficiency anemia**, and some **hemoglobin variants** (e.g., patients with **sickle cell disease** or **thalassemia**). In these cases, a **fasting plasma glucose** or **oral glucose tolerance test** should be used for screening or diagnosing diabetes.

Only A1c tests that have been referenced to an accepted laboratory method (National Glycohemoglobin Standardization Program certified) should be used for diagnostic or screening purposes. Currently, **point-of-care tests**, such as those that may be used at a doctor's office or a patient's bedside, are not accurate enough for use in diagnosis but can be used to monitor treatment (lifestyle and drug therapies).

Monitoring

The A1c test is also used to monitor the glucose control of diabetics over time. The goal of those with diabetes is to keep their blood glucose levels as close to normal as possible. This helps to minimize the complications caused by **chronically** elevated glucose levels, such as progressive damage to body organs like the kidneys, eyes, cardiovascular system, and nerves. The A1c test result gives a picture of the average amount of glucose in the blood over the last 2-3 months. This can help diabetics and their healthcare providers know if the measures that are being taken to control their diabetes are successful or need to be adjusted.

A1c is frequently used to help newly diagnosed diabetics determine how elevated their uncontrolled blood glucose levels have been over the last 2-3 months. The test may be ordered several times while control is being achieved, and then at least twice a year to verify that good control is being maintained.

When is it ordered?

Screening and diagnosis

A1c may be ordered as part of a health checkup or when someone is suspected of having **diabetes** because of classical **signs** or **symptoms** of increased **blood glucose levels (hyperglycemia)** such as:

- Increased thirst and drinking fluids
- Increased urination
- Increased appetite
- Fatigue
- Blurred vision
- Slow-healing infections

The A1c test may also be considered in adults who are overweight with the following additional risk factors:

- Physical inactivity
- First-degree relative (sibling or parent) with diabetes
- High-risk race/ethnicity (e.g., African American, Latino, Native American, Asian American, Pacific Islander)
- High blood pressure (**hypertension**)
- Abnormal lipid profile (low **HDL cholesterol** and/or high **triglycerides**)
- Women with **polycystic ovary syndrome**

- History of [cardiovascular diseases](#)
- Other clinical conditions associated with [insulin resistance](#)

The American Diabetes Association (ADA) recommends to begin A1c testing at age 45 for overweight or obese people; if the result is normal, the testing should be repeated at a minimum of 3-year intervals, with consideration of more frequent testing depending on initial results and risk status.

People who are not diagnosed with diabetes but are determined to be at increased risk for diabetes (prediabetes) should have A1c testing yearly.

Monitoring

Depending on the type of diabetes that a person has, how well that person's diabetes is controlled, and on the healthcare provider's recommendations, the A1c test may be measured 2 to 4 times each year. The ADA recommends A1c testing for diabetics at least twice a year if they are meeting treatment goals and under stable glycemic control. When someone is first diagnosed with diabetes or if control is not good, A1c may be ordered quarterly.

What does the test result mean?

In screening and diagnosis, some results that may be seen include:

- A nondiabetic person will have an A1c result less than 5.7% (39 mmol/mol).
- Diabetes: A1c level is 6.5% (48 mmol/mol) or higher.
- Increased risk of developing [diabetes](#) in the future: A1c of 5.7% to 6.4% (39-46 mmol/mol)

For monitoring glucose control, A1c is currently reported as a percentage and, for most diabetics, it is recommended that they aim to keep their hemoglobin A1c below 7%. The closer diabetics can keep their A1c to the American Diabetes Association (ADA)'s therapeutic goal of less than 7% without experiencing excessive low [blood glucose \(hypoglycemia\)](#), the better their diabetes is in control. As the A1c increases, so does the risk of complications.

An individual with [type 2 diabetes](#), however, may have an A1c goal selected by the person and his or her healthcare provider. The goal may depend on several factors, such as length of time since diagnosis, the presence of other diseases as well as diabetes complications (e.g., vision impairment or loss, kidney damage), risk of complications from hypoglycemia, limited life expectancy, and whether or not the person has a support system and healthcare resources readily available.

For example, a person with [heart disease](#) who has lived with type 2 diabetes for many years without diabetic complications may have a higher A1c target (e.g., 7.5%-8.0%) set by their healthcare provider, while someone who is otherwise healthy and just diagnosed may have a lower target (e.g., 6.0%-6.5%) as long as low blood sugar is not a significant risk.

The A1c test report also may include the result expressed in SI units (mmol/mol) and an estimated Average Glucose (eAG), which is a calculated result based on the hemoglobin A1c levels.

The purpose of reporting eAG is to help a person relate A1c results to everyday glucose monitoring levels and to laboratory glucose tests. The [formula](#) for eAG converts percentage A1c to units of mg/dL or mmol/L.

It should be noted that the eAG is still an evaluation of a person's glucose over the last couple of months. It will not match up exactly to any one daily glucose test result. The ADA has adopted this calculation and provides a calculator and information on the eAG on their [DiabetesPro web site](#). The [NGSP web site](#) also provides a calculator to convert hemoglobin A1c in SI units mmol/mol into percentage.

Is there anything else I should know?

The A1c test will not reflect temporary, [acute](#) blood glucose increases or decreases, or good control that has been achieved in the last 3-4 weeks. The glucose swings of someone who has "[brittle](#)" [diabetes](#) will also not be reflected in the A1c.

If an individual has a [hemoglobin variant](#), such as sickle cell hemoglobin (hemoglobin S), that person will have a decreased amount of hemoglobin A. This may limit the usefulness of the A1c test in diagnosing and/or monitoring this person's diabetes, depending on the method used.

If a person has [anemia](#), [hemolysis](#), or heavy bleeding, A1c test results may be falsely low. If someone is iron-deficient, the A1c level may be increased.

If a person receives erythropoietin therapy or has had a recent blood transfusion, the A1c may be inaccurate and may not accurately reflect glucose control for 2-3 months.

Common Questions

1. How is estimated Average Glucose (eAG) calculated?

The ADAG (A1c-Derived Average Glucose) formula that is used to calculate the eAG from your hemoglobin A1c (A1c) result is:

$$28.7 \times \text{A1c} (\%) - 46.7 = \text{eAG (milligrams/deciliter, mg/dL)}$$

An example of this is an A1c of 6%. The calculation for this would be:

$$28.7 \times 6 - 46.7 = 126 \text{ mg/dL}$$

for an estimated average glucose of 126 mg/dL.

What this means is that for every one percent that your A1c goes up, it is equivalent to your average glucose going up by about 29 mg/dL.

2. Is A1c reported the same way around the world?

For monitoring purposes, the way that the A1c is reported is in the process of changing. Traditionally, in the United States, the A1c has been reported as a percentage, and the American Diabetes Association (ADA) has recommended that people with diabetes strive to keep their A1c below 7%. While this is still generally true, more than a decade of national and international efforts to improve and standardize the A1c test and its reporting led to the release of a consensus statement in 2007 (and an update in 2010) by the ADA, the European Association for the Study of Diabetes (EASD), the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC), the International Society for Pediatric and Adolescent Diabetes, and the International Diabetes Federation. These joint statements and the completion of a study called ADAG (A1c-Derived Average Glucose) that further examined the relationship between blood glucose concentrations and A1c led to a recommendation that A1c be reported worldwide in two ways:

- As a percentage (based upon National Glycohemoglobin Standardization Program (NGSP) derived units) and
- In SI (Système International) units (mmol/mol)

An estimated Average Glucose (eAG) based upon a formula developed from the ADAG study with either mg/dL or mmol/l as units that continue to be recognized by the ADA and the American Association for Clinical Chemistry in the 2015 ADA Diabetes Care Position Statement may also be reported.

What this means for diabetics and health practitioners in the U.S. is that A1c results will be reported as a percentage but may in addition to this be reported as mmol/mol and, in some cases, also as an eAG with the same type of units (mg/dL) as are reported by home glucose monitors and laboratory results.

3. Is there a home test for hemoglobin A1c?

Yes. If you have already been diagnosed with **diabetes**, a home test may be used to help monitor your glucose control over time. However, a home test (**point-of-care test**) is not recommended for screening or diagnosing the disease. There are FDA-approved tests that can be used at home. If you are interested in learning more, visit the article on **Home Tests** and ask your healthcare provider.

4. Why are my A1c and blood glucose different?

Beyond the difference in units used to report them, the A1c represents an average over time while your **blood glucose** reflects what is happening in your body now. Your blood glucose will capture the changes in your blood sugar that occur on a daily basis, the highs and the lows. Each blood glucose is a snapshot and each is different. The A1c is an indication that "in general" your glucose has been elevated over the last few months or "in general" it has been normal. It is inherently not as **sensitive** as a blood glucose. However, if your day-to-day glucose control is stable (good or bad), then both the A1c and blood glucose should reflect this. It is important to remember the time lag associated with the A1c. Good glucose control for the past 2-3 weeks will not significantly affect the A1c result for several more weeks.

In addition to this, it is also important to remember that glycated hemoglobin and blood glucose are two different but related things. For unknown reasons, some peoples' A1c may not accurately reflect their average blood glucose.

Related Pages

On This Site

Conditions: [Diabetes](#)

In the News: [Screening, Diet and Exercise Key Factors in Task Force's New Diabetes Guidelines \(2015\)](#), [Task Force Updates Recommendations for Screening for Pre-Diabetes and Diabetes in Adults \(2014\)](#), [New Report Finds that Diabetes is on the Rise \(2014\)](#)

Elsewhere On The Web

[American Diabetes Association: Diabetes Basics](#)

[American Diabetes Association: Risk Test](#)

[American Association of Diabetes Educators](#)

[Centers for Disease Control and Prevention: Diabetes Public Health Resource](#)

[National Diabetes Information Clearinghouse: Prevent diabetes problems - Keep your diabetes under control](#)

[National Institute of Diabetes and Digestive and Kidney Diseases: Diabetes A to Z](#)

[National Glycohemoglobin Standardization Program](#)

[American Diabetes Association – DiabetesPro, estimated Average Glucose, eAG](#)

Article Sources

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