Diabetes Patient Education Fact Sheet

Selection Includes:

- **The A1C Test and Diabetes**
  Defines and explains the diabetes blood test called the A1C test. Provides in-depth information on using the test for both diagnosis of diabetes and prediabetes and maintenance of diabetes. Compares the A1C test to other diabetes blood tests. Discusses variation in the test and the range of answers given by diabetes blood tests in general.

- **Comparing Tests for Diabetes and Prediabetes: A Quick Reference Guide** (For Health Care Professionals)
  Provides a concise summary for health care providers of blood tests for diabetes and prediabetes, covering uses, technical features, and pros and cons of different tests. Information is displayed in a large table that can be put on the wall or kept on a desk.

- **Diabetes, Heart Disease, and Stroke**

Additional Resources Available at:

The A1C Test and Diabetes

What is the A1C test?
The A1C test is a blood test that provides information about a person’s average levels of blood glucose, also called blood sugar, over the past 3 months. The A1C test is sometimes called the hemoglobin A1c, HbA1c, or glycohemoglobin test. The A1C test is the primary test used for diabetes management and diabetes research.

Because the A1C test does not require fasting and blood can be drawn for the test at any time of day, experts are hoping its convenience will allow more people to get tested—thus, decreasing the number of people with undiagnosed diabetes. However, some medical organizations continue to recommend using blood glucose tests for diagnosis.

How does the A1C test work?
The A1C test is based on the attachment of glucose to hemoglobin, the protein in red blood cells that carries oxygen. In the body, red blood cells are constantly forming and dying, but typically they live for about 3 months. Thus, the A1C test reflects the average of a person’s blood glucose levels over the past 3 months. The A1C test result is reported as a percentage. The higher the percentage, the higher a person’s blood glucose levels have been. A normal A1C level is below 5.7 percent.

Why should a person be tested for diabetes?
Testing is especially important because early in the disease diabetes has no symptoms. Although no test is perfect, the A1C and blood glucose tests are the best tools available to diagnose diabetes—a serious and lifelong disease.

Testing enables health care providers to find and treat diabetes before complications occur and to find and treat prediabetes, which can delay or prevent type 2 diabetes from developing.

Can the A1C test be used to diagnose type 2 diabetes and prediabetes?
Yes. In 2009, an international expert committee recommended the A1C test as one of the tests available to help diagnose type 2 diabetes and prediabetes.1 Previously, only the traditional blood glucose tests were used to diagnose diabetes and prediabetes.

The A1C Test and Diabetes

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Has the A1C test improved?

Yes. A1C laboratory tests are now standardized. In the past, the A1C test was not recommended for diagnosis of type 2 diabetes and prediabetes because the many different types of A1C tests could give varied results. The accuracy has been improved by the National Glycohemoglobin Standardization Program (NGSP), which developed standards for the A1C tests.

The NGSP certifies that manufacturers of A1C tests provide tests that are consistent with those used in a major diabetes study. The study established current A1C goals for blood glucose control that can reduce the occurrence of diabetes complications, such as blindness and blood vessel disease.

How is the A1C test used to diagnose type 2 diabetes and prediabetes?

The A1C test can be used to diagnose type 2 diabetes and prediabetes alone or in combination with other diabetes tests. When the A1C test is used for diagnosis, the blood sample must be sent to a laboratory that uses an NGSP-certified method for analysis to ensure the results are standardized.

Blood samples analyzed in a health care provider’s office, known as point-of-care (POC) tests, are not standardized for diagnosing diabetes. The following table provides the percentages that indicate diagnoses of normal, diabetes, and prediabetes according to A1C levels.

<table>
<thead>
<tr>
<th>Diagnosis*</th>
<th>A1C Level</th>
</tr>
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<tbody>
<tr>
<td>Normal</td>
<td>below 5.7 percent</td>
</tr>
<tr>
<td>Diabetes</td>
<td>6.5 percent or above</td>
</tr>
<tr>
<td>Prediabetes</td>
<td>5.7 to 6.4 percent</td>
</tr>
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</table>

*Any test for diagnosis of diabetes requires confirmation with a second measurement unless there are clear symptoms of diabetes.

Having prediabetes is a risk factor for getting type 2 diabetes. People with prediabetes may be retested each year. Within the prediabetes A1C range of 5.7 to 6.4 percent, the higher the A1C, the greater the risk of diabetes. Those with prediabetes are likely to develop type 2 diabetes within 10 years, but they can take steps to prevent or delay diabetes.

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Is the A1C test used during pregnancy?
The A1C test may be used at the first visit to the health care provider during pregnancy to see if women with risk factors had undiagnosed diabetes before becoming pregnant. After that, the oral glucose tolerance test (OGTT) is used to test for diabetes that develops during pregnancy—known as gestational diabetes. After delivery, women who had gestational diabetes should be tested for persistent diabetes. Blood glucose tests, rather than the A1C test, should be used for testing within 12 weeks of delivery.

Can the A1C test result in a different diagnosis than the blood glucose tests?
Yes. In some people, a blood glucose test may indicate a diagnosis of diabetes while an A1C test does not. The reverse can also occur—an A1C test may indicate a diagnosis of diabetes even though a blood glucose test does not. Because of these variations in test results, health care providers repeat tests before making a diagnosis.

People with differing test results may be in an early stage of the disease, where blood glucose levels have not risen high enough to show on every test. Sometimes, making simple changes in lifestyle—losing a small amount of weight and increasing physical activity—can help people in this early stage reverse diabetes or delay its onset.

Can blood glucose tests still be used for diagnosing type 2 diabetes and prediabetes?
Yes. The standard blood glucose tests used for diagnosing type 2 diabetes and prediabetes—the fasting plasma glucose (FPG) test and the OGTT—are still recommended. The random plasma glucose test, also called the casual glucose test, may be used for diagnosing diabetes when symptoms of diabetes are present. In some cases, the A1C test is used to help health care providers confirm the results of a blood glucose test.
Are diabetes blood test results always accurate?

All laboratory test results can vary from day to day and from test to test. Results can vary

- **within the person being tested.** A person’s blood glucose levels normally move up and down depending on meals, exercise, sickness, and stress.

- **between different tests.** Each test measures blood glucose levels in a different way. For example, the FPG test measures glucose that is floating free in the blood after fasting and only shows the blood glucose level at the time of the test. Repeated blood glucose tests, such as self-monitoring several times a day with a home meter, can record the natural variations of blood glucose levels during the day. The A1C test represents the amount of glucose attached to hemoglobin, so it reflects an average of all the blood glucose levels a person may experience over 3 months. The A1C test will not show day-to-day changes.

The following chart shows how multiple blood glucose measurements over 4 days compare with an A1C measurement.

**Blood Glucose Measurements Compared with A1C Measurements Over 4 Days**

- **within the same test.** Even when the same blood sample is repeatedly measured in the same laboratory, the results may vary due to small changes in temperature, equipment, or sample handling.

Health care providers take these variations into account when considering test results and repeat laboratory tests for confirmation. Diabetes develops over time, so even with variations in test results, health care providers can tell when overall blood glucose levels are becoming too high.

Comparing test results from different laboratories can be misleading. People should consider requesting new laboratory tests when they change health care providers, or if their health care provider’s office changes the laboratory or clinic it uses for blood testing.
How accurate is the A1C test?

The A1C test result can be up to 0.5 percent higher or lower than the actual percentage. This means an A1C measured as 7.0 percent could indicate a true A1C anywhere in the range from ~6.5 to 7.5 percent. Health care providers can visit www.ngsp.org to find information about the accuracy of the A1C test used by their laboratory.

The drawing below illustrates the range of possible true values when an A1C is 7.0 percent on the lab report. This range is based on the inherent variability of the laboratory test, often referred to as the coefficient of variation. Different degrees of laboratory variability result in different ranges of possible true values. The range illustrated is the maximum allowed by test methods approved by NGSP.

Can the A1C test give false results?

Yes, for some people. The A1C test can be unreliable for diagnosing or monitoring diabetes in people with certain conditions that are known to interfere with the results. Interference should be suspected when A1C results seem very different from the results of a blood glucose test.

People of African, Mediterranean, or Southeast Asian descent, or people with family members with sickle cell anemia or a thalassemia are particularly at risk of interference. People in these groups may have a less common type of hemoglobin, known as a hemoglobin variant, that can interfere with some A1C tests. Most people with a hemoglobin variant have no symptoms and may not know that they carry this type of hemoglobin.

Not all of the A1C tests are unreliable for people with a hemoglobin variant. People with false results from one type of A1C test may need a different type of A1C test for measuring their average blood glucose level. The NGSP provides information for health care providers about which A1C tests are appropriate to use for specific hemoglobin variants at www.ngsp.org.
How is the A1C test used after diagnosis of diabetes?

Health care providers can use the A1C test to monitor blood glucose levels in people with type 1 or type 2 diabetes. The A1C test is not used to monitor gestational diabetes.

The American Diabetes Association recommends that people with diabetes who are meeting treatment goals and have stable blood glucose levels have the A1C test twice a year. Health care providers may repeat the A1C test as often as four times a year until blood glucose levels reach recommended levels.

The A1C test helps health care providers adjust medication to reduce the risk of long-term diabetes complications. Studies have demonstrated substantial reductions in long-term complications with the lowering of A1C levels.

When the A1C test is used for monitoring blood glucose levels in a person with diabetes, the blood sample can be analyzed in a health care provider's office using a POC test to give immediate results. However, POC tests are less reliable and not as accurate as most laboratory tests.

False A1C results may also occur in people with other problems that affect their blood or hemoglobin. For example, a falsely low A1C result can occur in people with

- anemia
- heavy bleeding

A falsely elevated A1C result can occur in people who

- are very low in iron, for example, those with iron deficiency anemia

Other causes of abnormal A1C results include

- kidney failure
- liver disease

More information about problems with the A1C test and different forms of sickle cell anemia is available in the following NDIC publications:

- For People of African, Mediterranean, or Southeast Asian Heritage: Important Information about Diabetes Blood Tests
- Sickle Cell Trait and Other Hemoglobinopathies and Diabetes: Important Information for Physicians

These publications are available at www.diabetes.niddk.nih.gov or by calling 1-800-860-8747.
How does the A1C relate to estimated average glucose?

Estimated average glucose (eAG) is calculated from the A1C. Some laboratories report eAG with the A1C test results. The eAG number helps people with diabetes relate their A1C to daily glucose monitoring levels. The eAG calculation converts the A1C percentage to the same units used by home glucose meters—milligrams per deciliter (mg/dL).

The eAG number will not match daily glucose readings because it is a long-term average rather than the blood glucose level at a single time, as measured with the home glucose meter. The following table shows the relationship between the A1C and the eAG.

<table>
<thead>
<tr>
<th>A1C</th>
<th>eAG</th>
</tr>
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<tbody>
<tr>
<td>Percent</td>
<td>mg/dL</td>
</tr>
<tr>
<td>6</td>
<td>126</td>
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<tr>
<td>7</td>
<td>154</td>
</tr>
<tr>
<td>8</td>
<td>183</td>
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<td>9</td>
<td>212</td>
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<td>10</td>
<td>240</td>
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<tr>
<td>11</td>
<td>269</td>
</tr>
<tr>
<td>12</td>
<td>298</td>
</tr>
</tbody>
</table>

What A1C target should people have?

People will have different A1C targets depending on their diabetes history and their general health. People should discuss their A1C target with their health care provider. Studies have shown that people with diabetes can reduce the risk of diabetes complications by keeping A1C levels below 7 percent.

Maintaining good blood glucose control will benefit those with new-onset diabetes for many years to come. However, an A1C level that is safe for one person may not be safe for another. For example, keeping an A1C level below 7 percent may not be safe if it leads to problems with hypoglycemia, also called low blood glucose.

Less strict blood glucose control, or an A1C between 7 and 8 percent—or even higher in some circumstances—may be appropriate in people who have

- limited life-expectancy
- long-standing diabetes and difficulty attaining a lower goal
- severe hypoglycemia
- advanced diabetes complications such as chronic kidney disease, nerve problems, or cardiovascular disease

Will the A1C test show changes in blood glucose levels?

Large changes in a person’s blood glucose levels over the past month will show up in their A1C test result but the A1C does not show sudden, temporary increases or decreases in blood glucose levels. Even though the A1C represents a long-term average, blood glucose levels within the past 30 days have a greater effect on the A1C reading than those in previous months.
Points to Remember

• The A1C test is a blood test that provides information about a person’s average levels of blood glucose, also called blood sugar, over the past 3 months.

• The A1C test is based on the attachment of glucose to hemoglobin, the protein in red blood cells that carries oxygen. Thus, the A1C test reflects the average of a person’s blood glucose levels over the past 3 months.

• In 2009, an international expert committee recommended the A1C test be used as one of the tests available to help diagnose type 2 diabetes and prediabetes.

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Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) conducts and supports research related to the causes, treatment, and prevention of diabetes. Many ongoing research studies use the AIC test to measure and compare the success of different treatments or medications for diabetes care. In addition, researchers continue to improve measurement of AIC.

Clinical trials are research studies involving people. Clinical trials look at safe and effective new ways to prevent, detect, or treat disease. Researchers also use clinical trials to look at other aspects of care, such as improving the quality of life for people with chronic illnesses. To learn more about clinical trials, why they matter, and how to participate, visit the NIH Clinical Research Trials and You website at www.nih.gov/health/clinicaltrials. For information about current studies, visit www.ClinicalTrials.gov.


For More Information

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www.yourdiabetesinfo.org

The National Diabetes Education Program is a federally funded program sponsored by the U.S. Department of Health and Human Services’ National Institutes of Health and the Centers for Disease Control and Prevention and includes over 200 partners at the federal, state, and local levels, working together to reduce the morbidity and mortality associated with diabetes.

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This publication is available at
www.diabetes.niddk.nih.gov

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The NIDDK prints on recycled paper with bio-based ink.

This fact sheet compares the following tests:
- A1C test
- fasting plasma glucose (FPG) test
- oral glucose tolerance test (OGTT)
- random plasma glucose (RPG) test

In addition, the National Diabetes Education Program (NDEP) offers a pocket guide, Diabetes Numbers At-a-Glance, which can be ordered at www.ndep.nih.gov. Both resources utilize current American Diabetes Association (ADA) clinical recommendations for diagnosing and managing diabetes and prediabetes.1

CONFIRMING DIAGNOSIS OF TYPE 2 DIABETES AND PREDIABETES

Diagnosis must be confirmed unless symptoms are present. Repeat the test using one of the following methods:

- Repeat the same test on a different day—preferred.
- If two different tests are used—e.g., FPG and A1C—and both indicate diabetes, consider the diagnosis confirmed.
- If the two different tests are discordant, repeat the test that is above the diagnostic cut point.

If diagnosis cannot be confirmed using the results of two tests, but at least one test indicates high risk, health care providers may wish to follow the patient closely and retest in 3 to 6 months.1

INTERPRETING LABORATORY RESULTS

When interpreting laboratory results health care providers should

- consider that all laboratory test results represent a range, rather than an exact number2
- be informed about the A1C assay methods used by their laboratory3
- send blood samples for diagnosis to a laboratory that uses an NGSP-certified method for A1C analysis to ensure the results are standardized4
- consider the possibility of interference in the A1C test when a result is above 15% or is at odds with other diabetes test results5
- consider each patient’s profile, including risk factors and history, and individualize diagnosis and treatment decisions in discussion with the patient6
## Comparing Diabetes Blood Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Uses</th>
<th>Technical Features</th>
<th>PROS</th>
<th>CONS</th>
</tr>
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<td>A1C Test</td>
<td>Screening and diagnosis of prediabetes</td>
<td>• Diagnosis requires a laboratory test certified by the NCCLS not met—point-of-care A1C tests are only 15% for monitoring.</td>
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<td>• Unaffected by acute illnesses, in glucose tests due to 400 mg/dL in diabetes patients.</td>
<td>• Interferes with certain medications (e.g., aspirin, ibuprofen).</td>
</tr>
<tr>
<td></td>
<td>28% of individuals are not met—point-of-care A1C tests are only 15% for monitoring.</td>
<td>• Prevents back-up testing with the FPG test and the OGTT.</td>
<td>• Many medications can be re-released and discontinued (diabetes control).</td>
<td>• Cautions for patient and health care provider.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sample size, no fasting.</td>
<td></td>
<td>• Cautions for patient and health care provider.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No need for additional testing (e.g., GGT, creatinine, cholesterol).</td>
<td></td>
<td>• Cautions for patient and health care provider.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Low within patient variability.</td>
<td></td>
<td>• Cautions for patient and health care provider.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Established measurement of test results</td>
<td></td>
<td>• Cautions for patient and health care provider.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Accuracy of test results is maintained.</td>
<td></td>
<td>• Cautions for patient and health care provider.</td>
</tr>
</tbody>
</table>

COMPARING DIAGNOSES

In some people, a blood glucose test may indicate a diagnosis of diabetes even though an A1C test does not.

The reverse can also occur—an A1C test may indicate a diagnosis of diabetes even though a blood glucose test does not.

Because of these variations in test results, health care providers should repeat tests before making a diagnosis. People with differing test results may be in an early stage of the disease, where blood glucose levels have not risen high enough to show on every test.

REFERENCES


3. See www.ndep.nih.gov for information on A1C test interference and recommended testing methods.

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Another quick-reference tool, Diabetes Numbers At-a-Glance 2012, is offered by the NDEP and is available at www.ndep.nih.gov.

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www.yourdiabetesinfo.org

The National Diabetes Education Program is a federally funded program sponsored by the U.S. Department of Health and Human Services’ National Institutes of Health and the Centers for Disease Control and Prevention and includes over 70 partners at the federal, state, and local levels, working together to reduce the morbidity and mortality associated with diabetes.

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The National Diabetes Information Clearinghouse (NDIC) is a service of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). The NIDDK is part of the National Institutes of Health of the U.S. Department of Health and Human Services. Established in 1978, the Clearinghouse provides information about diabetes to people with diabetes and to their families, health care professionals, and the public. The NDIC answers inquiries, develops and distributes publications, and works closely with professional and patient organizations and Government agencies to coordinate resources about diabetes.

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Diabetes, Heart Disease, and Stroke

Having diabetes or prediabetes puts you at increased risk for heart disease and stroke. You can lower your risk by keeping your blood glucose (also called blood sugar), blood pressure, and blood cholesterol close to the recommended target numbers—the levels suggested by diabetes experts for good health. (For more information about target numbers for people with diabetes, see page 6.) Reaching your targets also can help prevent narrowing or blockage of the blood vessels in your legs, a condition called peripheral arterial disease. You can reach your targets by

- choosing foods wisely
- being physically active
- taking medications if needed

If you have already had a heart attack or a stroke, taking care of yourself can help prevent future health problems.

What is diabetes?

Diabetes is a disorder of metabolism—the way our bodies use digested food for energy. Most of the food we eat is broken down into glucose, the form of sugar in the blood. Glucose is the body’s main source of fuel.

After digestion, glucose enters the bloodstream. Then glucose goes to cells throughout the body where it is used for energy. However, a hormone called insulin must be present to allow glucose to enter the cells. Insulin is a hormone produced by the pancreas, a large gland behind the stomach.

In people who do not have diabetes, the pancreas automatically produces the right amount of insulin to move glucose from blood into the cells. However, diabetes develops when the pancreas does not make enough insulin, or the cells in the muscles, liver, and fat do not use insulin properly, or both. As a result, the amount of glucose in the blood increases while the cells are starved of energy.
Over time, high blood glucose levels damage nerves and blood vessels, leading to complications such as heart disease and stroke, the leading causes of death among people with diabetes. Uncontrolled diabetes can eventually lead to other health problems as well, such as vision loss, kidney failure, and amputations.

**What is prediabetes?**
Prediabetes is a condition in which blood glucose levels are higher than normal but not high enough for a diagnosis of diabetes. Prediabetes is also called impaired fasting glucose or impaired glucose tolerance. Many people with prediabetes develop type 2 diabetes within 10 years. In addition, they are at risk for heart disease and stroke. With modest weight loss and moderate physical activity, people with prediabetes can delay or prevent type 2 diabetes and lower their risk of heart disease and stroke.

**What is the connection between diabetes, heart disease, and stroke?**
If you have diabetes, you are at least twice as likely as someone who does not have diabetes to have heart disease or a stroke. People with diabetes also tend to develop heart disease or have strokes at an earlier age than other people. If you are middle-aged and have type 2 diabetes, some studies suggest that your chance of having a heart attack is as high as someone without diabetes who has already had one heart attack. Women who have not gone through menopause usually have less risk of heart disease than men of the same age. But women of all ages with diabetes have an increased risk of heart disease because diabetes cancels out the protective effects of being a woman in her child-bearing years.

People with diabetes who have already had one heart attack run an even greater risk of having a second one. In addition, heart attacks in people with diabetes are more serious and more likely to result in death. High blood glucose levels over time can lead to increased deposits of fatty materials on the insides of the blood vessel walls. These deposits may affect blood flow, increasing the chance of clogging and hardening of blood vessels (atherosclerosis).
What are the risk factors for heart disease and stroke in people with diabetes?

Diabetes itself is a risk factor for heart disease and stroke. Also, many people with diabetes have other conditions that increase their chance of developing heart disease and stroke. These conditions are called risk factors. One risk factor for heart disease and stroke is **having a family history of heart disease**. If one or more members of your family had a heart attack at an early age (before age 55 for men or 65 for women), you may be at increased risk.

You can’t change whether heart disease runs in your family, but you can take steps to control the other risk factors for heart disease listed here:

- **Having central obesity.** Central obesity means carrying extra weight around the waist, as opposed to the hips. A waist measurement of more than 40 inches for men and more than 35 inches for women means you have central obesity. Your risk of heart disease is higher because abdominal fat can increase the production of LDL (bad) cholesterol, the type of blood fat that can be deposited on the inside of blood vessel walls.

- **Having abnormal blood fat (cholesterol) levels.**
  - LDL cholesterol can build up inside your blood vessels, leading to narrowing and hardening of your arteries—the blood vessels that carry blood from the heart to the rest of the body. Arteries can then become blocked. Therefore, high levels of LDL cholesterol raise your risk of getting heart disease.
  - Triglycerides are another type of blood fat that can raise your risk of heart disease when the levels are high.
  - HDL (good) cholesterol removes deposits from inside your blood vessels and takes them to the liver for removal. Low levels of HDL cholesterol increase your risk for heart disease.

- **Having high blood pressure.** If you have high blood pressure, also called hypertension, your heart must work harder to pump blood. High blood pressure can strain the heart, damage blood vessels, and increase your risk of heart attack, stroke, eye problems, and kidney problems.

- **Smoking.** Smoking doubles your risk of getting heart disease. Stopping smoking is especially important for people with diabetes because both smoking and diabetes narrow blood vessels. Smoking also increases the risk of other long-term complications, such as eye problems. In addition, smoking can damage the blood vessels in your legs and increase the risk of amputation.
What is metabolic syndrome and how is it linked to heart disease?

Metabolic syndrome is a grouping of traits and medical conditions that puts people at risk for both heart disease and type 2 diabetes. It is defined by the National Cholesterol Education Program as having any three of the following five traits and medical conditions:

<table>
<thead>
<tr>
<th>Traits and Medical Conditions</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated waist circumference</td>
<td>Waist measurement of</td>
</tr>
<tr>
<td></td>
<td>- 40 inches or more in men</td>
</tr>
<tr>
<td></td>
<td>- 35 inches or more in women</td>
</tr>
<tr>
<td>Elevated levels of triglycerides</td>
<td>• 150 mg/dL or higher</td>
</tr>
<tr>
<td></td>
<td>or Taking medication for elevated triglyceride levels</td>
</tr>
<tr>
<td>Low levels of HDL (good) cholesterol</td>
<td>• Below 40 mg/dL in men</td>
</tr>
<tr>
<td></td>
<td>or Below 50 mg/dL in women</td>
</tr>
<tr>
<td></td>
<td>or Taking medication for low HDL cholesterol levels</td>
</tr>
<tr>
<td>Elevated blood pressure levels</td>
<td>• 130 mm Hg or higher for systolic blood pressure or</td>
</tr>
<tr>
<td></td>
<td>• 85 mm Hg or higher for diastolic blood pressure or</td>
</tr>
<tr>
<td></td>
<td>or Taking medication for elevated blood pressure levels</td>
</tr>
<tr>
<td>Elevated fasting blood glucose levels</td>
<td>• 100 mg/dL or higher</td>
</tr>
<tr>
<td></td>
<td>or Taking medication for elevated blood glucose levels</td>
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</tbody>
</table>


Note: Other definitions of similar conditions have been developed by the American Association of Clinical Endocrinologists, the International Diabetes Federation, and the World Health Organization.

4  Diabetes, Heart Disease, and Stroke
What can I do to prevent or delay heart disease and stroke?

Even if you are at high risk for heart disease and stroke, you can help keep your heart and blood vessels healthy. You can do so by taking the following steps:

- Make sure that your diet is “heart-healthy.” Meet with a registered dietitian to plan a diet that meets these goals:
  - Include at least 14 grams of fiber daily for every 1,000 calories consumed. Foods high in fiber may help lower blood cholesterol. Oat bran, oatmeal, whole-grain breads and cereals, dried beans and peas (such as kidney beans, pinto beans, and black-eyed peas), fruits, and vegetables are all good sources of fiber. Increase the amount of fiber in your diet gradually to avoid digestive problems.
  - Cut down on saturated fat. It raises your blood cholesterol level. Saturated fat is found in meats, poultry skin, butter, dairy products with fat, shortening, lard, and tropical oils such as palm and coconut oil. Your dietitian can figure out how many grams of saturated fat should be your daily maximum amount.
  - Keep the cholesterol in your diet to less than 300 milligrams a day. Cholesterol is found in meat, dairy products, and eggs.
  - Keep the amount of trans fat in your diet to a minimum. It’s a type of fat in foods that raises blood cholesterol. Limit your intake of crackers, cookies, snack foods, commercially prepared baked goods, cake mixes, microwave popcorn, fried foods, salad dressings, and other foods made with partially hydrogenated oil. In addition, some kinds of vegetable shortening and margarines have trans fat. Check for trans fat in the Nutrition Facts section on the food package.
  - If you smoke, quit. Your doctor can help you find ways to quit smoking.
  - Ask your doctor whether you should take aspirin. Studies have shown that taking a low dose of aspirin every day can help reduce the risk of heart disease and stroke. However, aspirin is not safe for everyone. Your doctor can tell you whether taking aspirin is right for you and exactly how much to take.
  - Get prompt treatment for transient ischemic attacks (TIAs). Early treatment for TIAs, sometimes called mini-strokes, may help prevent or delay a future stroke. Signs of a TIA are sudden weakness, loss of balance, numbness, confusion, blurred vision in one or both eyes, double vision, difficulty speaking, or a severe headache.

5 Diabetes, Heart Disease, and Stroke
How will I know whether my diabetes treatment is working?

You can keep track of the ABCs of diabetes to make sure your treatment is working. Talk with your health care provider about the best targets for you.

A stands for A1C (a test that measures blood glucose control). Have an A1C test at least twice a year. It shows your average blood glucose level over the past 3 months. Talk with your doctor about whether you should check your blood glucose at home and how to do it.

<table>
<thead>
<tr>
<th>A1C target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 7 percent, unless your doctor sets a different target</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blood glucose targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before meals</td>
</tr>
<tr>
<td>1 to 2 hours after the start of a meal</td>
</tr>
</tbody>
</table>

B is for blood pressure. Have it checked at every office visit.

<table>
<thead>
<tr>
<th>Blood pressure target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 140/80 mm Hg, unless your doctor sets a different target</td>
</tr>
</tbody>
</table>

C is for cholesterol. Have it checked at least once a year.

<table>
<thead>
<tr>
<th>Blood fat (cholesterol) targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDL (bad) cholesterol</td>
</tr>
<tr>
<td>Triglycerides</td>
</tr>
<tr>
<td>HDL (good) cholesterol</td>
</tr>
<tr>
<td>For men: above 40 mg/dL</td>
</tr>
<tr>
<td>For women: above 50 mg/dL</td>
</tr>
</tbody>
</table>

Control of the ABCs of diabetes can reduce your risk for heart disease and stroke. If your blood glucose, blood pressure, and cholesterol levels aren’t on target, ask your doctor what changes in diet, activity, and medications can help you reach these goals.

What types of heart and blood vessel disease occur in people with diabetes?

Two major types of heart and blood vessel disease, also called cardiovascular disease, are common in people with diabetes: coronary artery disease (CAD) and cerebral vascular disease. People with diabetes are also at risk for heart failure. Narrowing or blockage of the blood vessels in the legs, a condition called peripheral arterial disease, can also occur in people with diabetes.

Coronary Artery Disease

Coronary artery disease, also called ischemic heart disease, is caused by a hardening or thickening of the walls of the blood vessels that go to your heart. Your blood supplies oxygen and other materials your heart needs for normal functioning. If the blood vessels to your heart become narrowed or blocked by fatty deposits, the blood supply is reduced or cut off, resulting in a heart attack.

Cerebral Vascular Disease

Cerebral vascular disease affects blood flow to the brain, leading to strokes and TIs. It is caused by narrowing, blocking, or hardening of the blood vessels that go to the brain or by high blood pressure.
Stroke
A stroke results when the blood supply to the brain is suddenly cut off, which can occur when a blood vessel in the brain or neck is blocked or bursts. Brain cells are then deprived of oxygen and die. A stroke can result in problems with speech or vision or can cause weakness or paralysis. Most strokes are caused by fatty deposits or blood clots—jelly-like clumps of blood cells—that narrow or block one of the blood vessels in the brain or neck. A blood clot may stay where it formed or can travel within the body. People with diabetes are at increased risk for strokes caused by blood clots.

A stroke may also be caused by a bleeding blood vessel in the brain. Called an aneurysm, a break in a blood vessel can occur as a result of high blood pressure or a weak spot in a blood vessel wall.

TIAs
TIAs are caused by a temporary blockage of a blood vessel to the brain. This blockage leads to a brief, sudden change in brain function, such as temporary numbness or weakness on one side of the body. Sudden changes in brain function also can lead to loss of balance, confusion, blindness in one or both eyes, double vision, difficulty speaking, or a severe headache. However, most symptoms disappear quickly and permanent damage is unlikely. If symptoms do not resolve in a few minutes, rather than a TIA, the event could be a stroke. The occurrence of a TIA means that a person is at risk for a stroke sometime in the future. See page 3 for more information on risk factors for stroke.

Heart Failure
Heart failure is a chronic condition in which the heart cannot pump blood properly—it does not mean that the heart suddenly stops working. Heart failure develops over a period of years, and symptoms can get worse over time. People with diabetes have at least twice the risk of heart failure as other people. One type of heart failure is congestive heart failure, in which fluid builds up inside body tissues. If the buildup is in the lungs, breathing becomes difficult.

Blockage of the blood vessels and high blood glucose levels also can damage heart muscle and cause irregular heartbeats. People with damage to heart muscle, a condition called cardiomyopathy, may have no symptoms in the early stages, but later they may experience weakness, shortness of breath, a severe cough, fatigue, and sweating of the legs and feet. Diabetes can also interfere with pain signals normally carried by the nerves, explaining why a person with diabetes may not experience the typical warning signs of a heart attack.

Peripheral Arterial Disease
Another condition related to heart disease and common in people with diabetes is peripheral arterial disease (PAD). With this condition, the blood vessels in the legs are narrowed or blocked by fatty deposits, decreasing blood flow to the legs and feet. PAD increases the chances of a heart attack or stroke occurring. Poor circulation in the legs and feet also raises the risk of amputation. Sometimes people with PAD develop pain in the calf or other parts of the leg when walking, which is relieved by resting for a few minutes.
How will I know whether I have heart disease?
One sign of heart disease is angina, the pain that occurs when a blood vessel to the heart is narrowed and the blood supply is reduced. You may feel pain or discomfort in your chest, shoulders, arms, jaw, or back, especially when you exercise. The pain may go away when you rest or take angina medicine. Angina does not cause permanent damage to the heart muscle, but if you have angina, your chance of having a heart attack increases.

A heart attack occurs when a blood vessel to the heart becomes blocked. With blockage, not enough blood can reach that part of the heart muscle and permanent damage results. During a heart attack, you may have

- chest pain or discomfort
- pain or discomfort in your arms, back, jaw, neck, or stomach
- shortness of breath
- sweating
- nausea
- light-headedness

Symptoms may come and go. However, in some people, particularly those with diabetes, symptoms may be mild or absent due to a condition in which the heart rate stays at the same level during exercise, inactivity, stress, or sleep. Also, nerve damage caused by diabetes may result in lack of pain during a heart attack.

Women may not have chest pain but may be more likely to have shortness of breath, nausea, or back and jaw pain. If you have symptoms of a heart attack, call 911 right away. Treatment is most effective if given within an hour of a heart attack. Early treatment can prevent permanent damage to the heart.

Your doctor should check your risk for heart disease and stroke at least once a year by checking your cholesterol and blood pressure levels and asking whether you smoke or have a family history of premature heart disease. The doctor can also check your urine for protein, another risk factor for heart disease. If you are at high risk or have symptoms of heart disease, you may need to undergo further testing.

What are the treatment options for heart disease?
Treatment for heart disease includes meal planning to ensure a heart-healthy diet and physical activity. In addition, you may need medications to treat heart damage or to lower your blood glucose, blood pressure, and cholesterol. If you are not already taking a low dose of aspirin every day, your doctor may suggest it. You also may need surgery or some other medical procedure.

For additional information about heart and blood vessel disease, high blood pressure, and high cholesterol, call the National Heart, Lung, and Blood Institute Health Information Center at 301–592–8573 or see www.nhlbi.nih.gov on the Internet.
How will I know whether I have had a stroke?
The following signs may mean that you have had a stroke:

- sudden weakness or numbness of your face, arm, or leg on one side of your body
- sudden confusion, trouble talking, or trouble understanding
- sudden dizziness, loss of balance, or trouble walking
- sudden trouble seeing out of one or both eyes or sudden double vision
- sudden severe headache

If you have any of these symptoms, call 911 right away. You can help prevent permanent damage by getting to a hospital within an hour of a stroke. If your doctor thinks you have had a stroke, you may have tests such as a neurological examination to check your nervous system, special scans, blood tests, ultrasound examinations, or x rays. You also may be given medication that dissolves blood clots.

What are the treatment options for stroke?
At the first sign of a stroke, you should get medical care right away. If blood vessels to your brain are blocked by blood clots, the doctor can give you a “clot-busting” drug. The drug must be given soon after a stroke to be effective. Subsequent treatment for stroke includes medications and physical therapy, as well as surgery to repair the damage. Meal planning and physical activity may be part of your ongoing care. In addition, you may need medications to lower your blood glucose, blood pressure, and cholesterol and to prevent blood clots.

For additional information about strokes, call the National Institute of Neurological Disorders and Stroke at 1-800-352-9424 or see www.ninds.nih.gov on the Internet.
Points to Remember

- If you have diabetes, you are at least twice as likely as other people to have heart disease or a stroke.
- Controlling the ABCs of diabetes—A1C (blood glucose), blood pressure, and cholesterol—can cut your risk of heart disease and stroke.
- Choosing foods wisely, quitting smoking, and taking medications (if needed) can all help lower your risk of heart disease and stroke.
- If you have any warning signs of a heart attack or a stroke, get medical care immediately—don’t delay. Early treatment of heart attack and stroke in a hospital emergency room can reduce damage to the heart and the brain.

Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) is one of the National Institutes of Health (NIH) under the U.S. Department of Health and Human Services. The NIDDK conducts and supports research in diabetes, glucose metabolism, and related conditions. Several studies related to diabetes, heart disease, and stroke are underway.

- The Look AHEAD (Action for Health in Diabetes) trial is studying whether strategies for weight loss in obese people with type 2 diabetes can improve health. This trial is also sponsored by other NIH Institutes and by the Centers for Disease Control and Prevention. For more information on the Look AHEAD trial, visit the website at www.niddk.nih.gov/news/for-reporters/look-ahead-action-health-diabetes/Pages/default.aspx.

- The EDIC (Epidemiology of Diabetes Interventions and Complications) study is examining the long-term effects of prior intensive versus conventional blood glucose control. It is a follow-up study of patients who took part more than a decade ago in the Diabetes Control and Complications Trial (DCCT), a major clinical study funded by the National Institutes of Health.

- The BARI 2D (Bypass Angioplasty Revascularization Investigation 2 Diabetes) trial, sponsored by the National Heart, Lung, and Blood Institute, in partnership with NIDDK, is studying approaches to the medical care of people with type 2 diabetes who also have coronary artery disease. For more information on the BARI 2D trial, visit the website at www.bar2d.org or call the nearest research center (listed on the website).

- The ACCORD (Action to Control Cardiovascular Risk in Diabetes) trial is studying three approaches to preventing major cardiovascular events in individuals with type 2 diabetes. For more information on the ACCORD trial, visit the website at www.acCORDtrial.org or call 1-888-342-2380.

- The NIDDK and other components of the NIH will continue to fund research on the best ways to enhance health promotion, self-management, and risk reduction in people with diabetes.
Clinical trials are research studies involving people. Clinical trials look at safe and effective new ways to prevent, detect, or treat disease. Researchers also use clinical trials to look at other aspects of care, such as improving the quality of life for people with chronic illnesses. To learn more about clinical trials, why they matter, and how to participate, visit the NIH Clinical Research Trials and You website at www.nih.gov/health/clinicaltrials. For information about current studies, visit www.ClinicalTrials.gov.


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(1–800–342–2383)
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American Association of Diabetes Educators
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Internet: www.jdrf.org

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