

**REVIEWED***By Chris Tighe at 12:22 pm, Feb 08, 2016*

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Health Information

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Diagnostic Tests

A1C Test and Diabetes

## The A1C Test and Diabetes

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### Alternate Versions

- [PDF Version \(568 KB\)](#)

You can also order print versions from our [online catalog](#). [NIDDK](#)

### Additional Links

- [Diagnosis of Diabetes and Prediabetes](#)
- [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](#)

### Contact Us

Health Information Center

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### Diabetes Disease

### What is the A1C test?

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

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### How does the A1C test work?

The A1C test is based on the attachment of glucose to hemoglobin, the protein in red blood cells. In the body, red blood cells are constantly forming and dying, but typically they live for about 3 months. The A1C test reflects the average of a person's blood glucose levels over the past 3 months. The A1C test is reported as a percentage. The higher the percentage, the higher a person's blood glucose levels have been. The goal is to keep the A1C test result below 5.7 percent.

## Organizations

There are many organizations who provide support for patients and medical professionals. View the full list of  [Diabetes Disease Organizations](#) (PDF, 293 KB).

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### 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 for type 2 diabetes and prediabetes.<sup>1</sup> Previously, only the traditional blood glucose tests were used to diagnose prediabetes.

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

<sup>1</sup>The International Expert Committee. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. *Diabetes Care*. 2009;32(7):1327–1334.

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### Why should a person be tested for diabetes?

Testing is especially important because early in the disease diabetes has no symptoms. Although A1C and blood glucose tests are the best tools available to diagnose diabetes—a serious and long-term condition.

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

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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 diabetes and prediabetes because the many different types of A1C tests could give varied results. This was improved by the National Glycohemoglobin Standardization Program (NGSP), which developed standardized tests.

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

<sup>2</sup>Nathan DM, Genuth S, Lachin J, et al. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *The New England Journal of Medicine*. 1993;329(14):977–986.

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### 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 tests. When the A1C test is used for diagnosis, the blood sample must be sent to a laboratory that uses a standardized 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 used to diagnose diabetes. The following table provides the percentages that indicate diagnoses of normal blood glucose, prediabetes, and diabetes according to A1C levels.

Diagnosis*	A1C Level
------------	-----------

Normal	below 5.7 percent
Diabetes	6.5 percent or above
Prediabetes	5.7 to 6.4 percent

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

Having prediabetes is a risk factor for getting type 2 diabetes. People with prediabetes may be in the prediabetes A1C range of 5.7 to 6.4 percent, the higher the A1C, the greater the risk of developing type 2 diabetes. People with prediabetes are likely to develop type 2 diabetes within 10 years, but they can take steps to prevent it.

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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 you have had undiagnosed diabetes before becoming pregnant. After that, the oral glucose tolerance test is used to diagnose diabetes that develops during pregnancy—known as gestational diabetes. After delivery, women with gestational diabetes should be tested for persistent diabetes. Blood glucose tests, rather than the A1C test, are used for testing within 12 weeks of delivery.

More information about diagnosing and treating gestational diabetes is available in the National Diabetes Clearinghouse's (NDIC's) publication [What I need to know about Gestational Diabetes](#) or by calling 1-800-860-8747.

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### 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 RPGT, may be used for diagnosing diabetes when symptoms of diabetes are present. In some cases, health care providers use blood glucose tests to help confirm the results of an A1C test.

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### Can the A1C test result in a different diagnosis than the blood glucose test?

Yes. In some people, a blood glucose test may indicate a diagnosis of diabetes while an A1C test may indicate a diagnosis of prediabetes. In other cases, a blood glucose test may indicate a diagnosis of prediabetes while an A1C test may indicate a diagnosis of diabetes. In 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 are not 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.

More information about diagnosing diabetes and prediabetes is available in the NDIC's fact sheet [Diabetes and Prediabetes](#) or by calling 1-800-860-8747.

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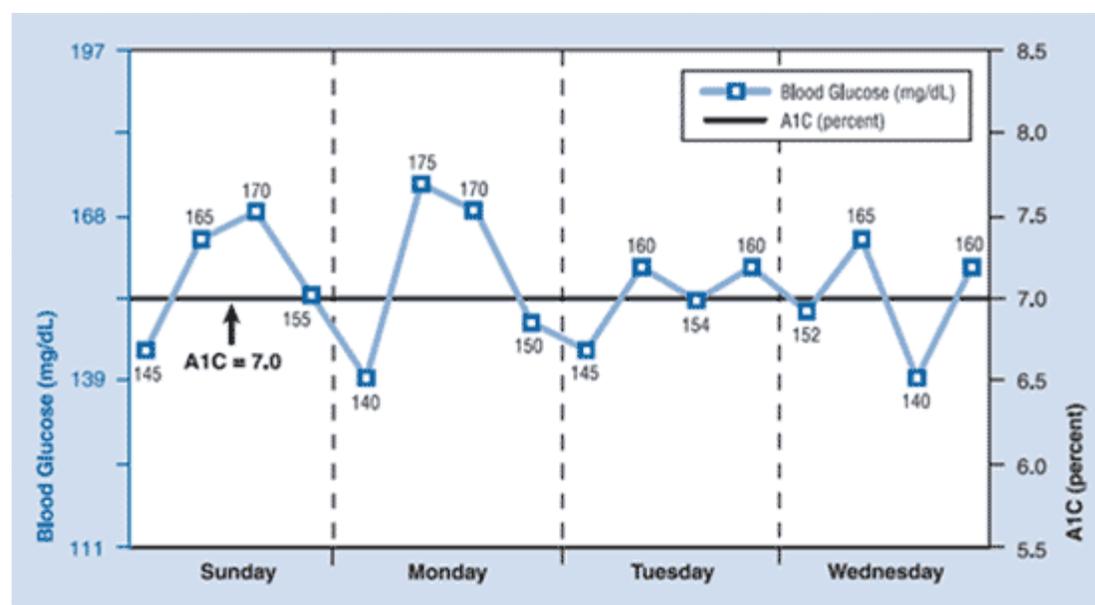
## Are diabetes blood test results always accurate?

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 throughout the day due to meals, exercise, sickness, and stress.
- **between different tests.** Each test measures blood glucose levels in a different way. Fasting blood glucose 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, can record the natural variations of blood glucose levels during the day. The A1C test measures glucose attached to hemoglobin, so it reflects an average of all the blood glucose levels a person has over the past 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



Note: Blood glucose (mg/dL) measurements were taken four times per day (fasting or pre-breakfast and bedtime).

The straight black line indicates an A1C measurement of 7.0 percent. The blue line shows blood glucose self-monitoring four times a day over a 4-day period.

- **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 testing. Diabetes develops over time, so even with variations in test results, health care providers may notice that overall blood glucose levels are becoming too high.

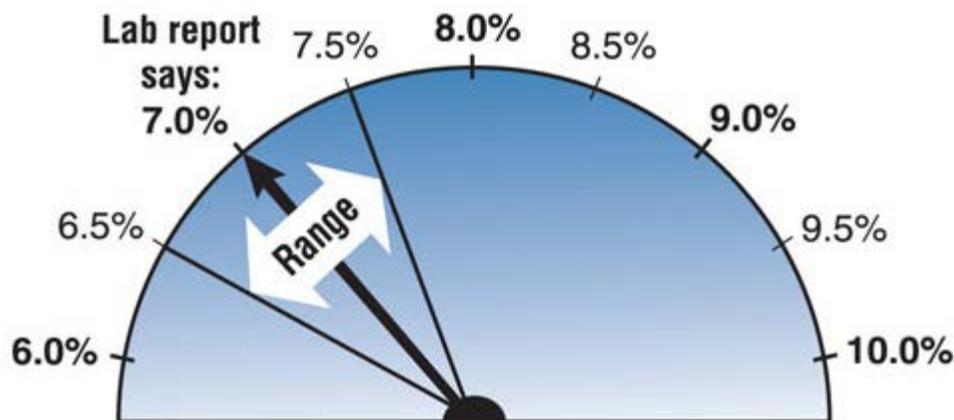
Comparing test results from different laboratories can be misleading. People should consider repeat testing when they change health care providers, or if their health care provider's office changes testing procedures or uses for blood testing.

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## How accurate is the A1C test?

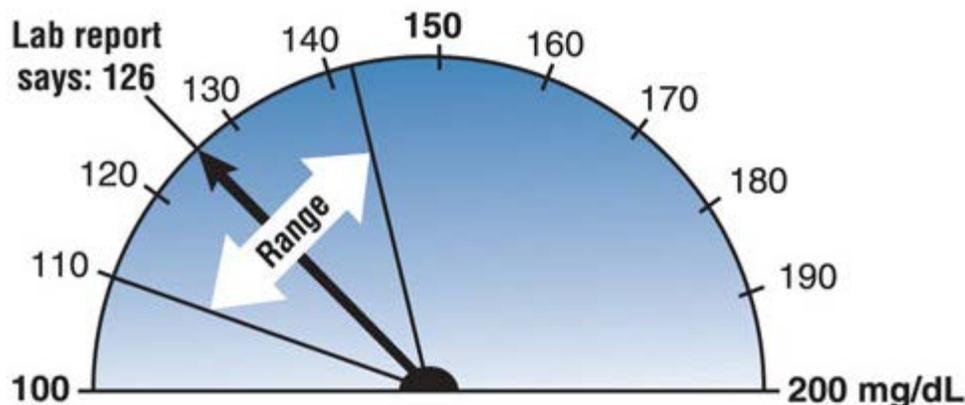
The A1C test result can be up to 0.5 percent higher or lower than the actual percentage. This means that a reported result of 7.0 percent could indicate a true A1C anywhere in the range from ~6.5 to 7.5 percent. For more information, visit [www.ngsp.org](http://www.ngsp.org) to find information about 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 a laboratory test. This range is based on the inherent variability of the laboratory test, often referred to as the coefficient of variation. The range of possible true values varies in different ranges of possible true values. The range illustrated is for test methods approved by NGSP.



Courtesy of David Aron, M.D., Louis Stokes Department of Veterans Affairs Medical Center

To put the A1C test into perspective, an FPG test result of 126 mg/dL obtained from a laboratory test could indicate a true FPG anywhere in the range of 110 to 140 mg/dL. This variation will be even greater if the blood sample is not processed promptly or is not put on ice, as glucose levels in the sample tend to decrease. The drawing below illustrates the range of possible true values for a reported 126 mg/dL.



Courtesy of David Aron, M.D., Louis Stokes Department of Veterans Affairs Medical Center

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## Can the A1C test give false results?

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

People of African, Mediterranean, or Southeast Asian descent, or people with family members who have thalassemia are particularly at risk of interference. People in these groups may have a less correlated A1C result.

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 a false A1C test may need a different type of A1C test for measuring their average blood glucose level. For more information for health care providers about which A1C tests are appropriate to use for specific hemoglobin variants, visit [www.ngsp.org](http://www.ngsp.org).

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 Hemoglobin Variants and Blood Tests](#)
- [Sickle Cell Trait and Other Hemoglobinopathies and Diabetes: Important Information for Health Care Providers](#)

False A1C results may also occur in people with other problems that affect their blood or hemoglobin. 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 false A1C results include

- kidney failure
- liver disease

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## 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 and 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 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. People who 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 is analyzed in a health care provider's office using a POC test to give immediate results. However, POC tests are not as reliable and not as accurate as most laboratory tests.

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## How does the A1C relate to estimated average glucose?

Estimated average glucose (eAG) is calculated from the A1C. Some laboratories report eAG with a milligram per deciliter (mg/dL) number. The eAG number helps people with diabetes relate their A1C to daily glucose monitoring levels. The eAG is converted from 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 a level at a single time, as measured with the home glucose meter. The following table shows the relationship between A1C and the eAG.

### Relationship between A1C and eAG

A1C	eAG
Percent	mg/dL
6	126
7	154
8	183
9	212
10	240
11	269
12	298

Source: Adapted from American Diabetes Association. Standards of medical care in diabetes—2014. Diabetes Care. 2014;37(1):S8-S12. Table 8.

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### What A1C target should people have?

People will have different A1C targets depending on their diabetes history and their general health. It's important to discuss your A1C target with your health care provider. Studies have shown that people with diabetes can reduce their 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. However, a target 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 cases—may be more 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

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### 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. A1C does not show sudden, temporary increases or decreases in blood glucose levels. Even though long-term average, blood glucose levels within the past 30 days have a greater effect on the A1C than previous months.

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## Points to Remember

- The A1C test is a blood test that provides information about a person's average levels of 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 ways to diagnose type 2 diabetes and prediabetes.
- Because the A1C test does not require fasting and blood can be drawn for the test at any time, hoping its convenience will allow more people to get tested—thus, decreasing the number of undiagnosed diabetes.
- In the past, the A1C test was not recommended for diagnosis of type 2 diabetes and prediabetes because many different types of A1C tests could give varied results. The accuracy has been improved by the Glycohemoglobin Standardization Program (NGSP), which developed standards for the A1C test. A1C tests analyzed in a health care provider's office, known as point-of-care (POC) tests, are not recommended for diagnosing diabetes.
- The A1C test may be used at the first visit to the health care provider during pregnancy for women who had undiagnosed diabetes before becoming pregnant. After that, the oral glucose tolerance test is used to test for diabetes that develops during pregnancy—known as gestational diabetes.
- 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 may be used to diagnose diabetes when symptoms of diabetes are present.
- The A1C test can be unreliable for diagnosing or monitoring diabetes in people with certain conditions known to interfere with the results.
- The American Diabetes Association recommends that people with diabetes who are meeting their goals and have stable blood glucose levels have the A1C test twice a year.
- Estimated average glucose (eAG) is calculated from the A1C to help people with diabetes understand their glucose monitoring levels.
- People will have different A1C targets depending on their diabetes history and their general health. Discuss their A1C target with their health care provider.

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## Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) conducts and supports research on the causes, treatment, and prevention of diabetes. Many ongoing research studies use the A1C test to compare the success of different treatments or medications for diabetes care. In addition, research is being done on the measurement of A1C.

Clinical trials are research studies involving people. Clinical trials look at safe and effective new treatments to 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 Clinical Research Trials and You website at [www.nih.gov/health/clinicaltrials](http://www.nih.gov/health/clinicaltrials) <sup>NIH</sup>. For information on clinical trials, visit [www.ClinicalTrials.gov](http://www.ClinicalTrials.gov).

Read more about the NIDDK's research on diabetes and related topics at <http://www.niddk.nih.gov>.

[areas/diabetes/Pages/diabetes.aspx](https://www.niddk.nih.gov/health-information/health-topics/diagnostic-tests/a1c-test-diabetes/Pages/diabetes.aspx)

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## For More Information

### American Association of Diabetes Educators

200 West Madison Street, Suite 800

Chicago, IL 60606

Phone: 1-800-338-3633

Internet: [www.diabeteseducator.org](http://www.diabeteseducator.org) 

### American Diabetes Association

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Fax: 703-549-6995

Email: [askADA@diabetes.org](mailto:askADA@diabetes.org)

Internet: [www.diabetes.org](http://www.diabetes.org) 

### JDRF

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Email: [info@jdrf.org](mailto:info@jdrf.org)

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You may also find additional information about this topic by visiting MedlinePlus at [www.medlineplus.gov](http://www.nlm.nih.gov/medlineplus)

This publication may contain information about medications and, when taken as prescribed, may help improve your health. When prepared, this publication included the most current information available. For updates on any medications, contact the U.S. Food and Drug Administration toll-free at 1-888-INFO-FDA or visit [www.fda.gov](http://www.fda.gov) . Consult your health care provider for more information.

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## National Diabetes Education Program

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Internet: [www.ndep.nih.gov](http://www.ndep.nih.gov) [NIDDK](#)

The National Diabetes Education Program is a federally funded program sponsored by the U.S. Human Services' National Institutes of Health and the Centers for Disease Control and Prevent partners at the federal, state, and local levels, working together to reduce the morbidity and mo diabetes.

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## National Diabetes Information Clearinghouse

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

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