

## Hemoglobin A1c (HbA1c)

### WHAT IS HEMOGLOBIN A1c?

Hemoglobin A1c (HbA1c) is glycated hemoglobin, which forms when hemoglobin within red blood cells joins with glucose. HbA1c levels reflect the average blood glucose level during the preceding 2-3 months. This differs from a blood glucose test, which measures the concentration of glucose at only the point at which the blood sample was collected. Measurement of HbA1c is useful for assessing diabetes risk, diagnosis, and control, as well as part of an evaluation of cardiac health (1).

### PURPOSE ON AN HBA1C TEST

This test is commonly used to diagnose diabetes or identify people with prediabetes. Prediabetes is a condition with slightly elevated blood sugar levels that is associated with an increased risk of developing diabetes. If you have previously been diagnosed with diabetes, your healthcare team may also use an HbA1c test to help manage your diabetes.

HbA1c tests have two big advantages over standard blood glucose tests:

1. HbA1c tests provide an average blood glucose level for the preceding 2–3 months. Blood glucose tests only measure the concentration of glucose at the timepoint at which the blood sample was collected. Blood glucose fluctuates a lot, depending on recent food consumption and physical activity, stress, illness, pain, dehydration, and even the time of the menstrual cycle.
2. HbA1c tests do not require fasting beforehand, unlike glucose tests that often require a period of fasting to obtain an accurate result.

### HbA1c REFERENCE RANGES

HbA1c levels can be reported as a percentage of hemoglobin that has glucose stuck to it (%HbA1c, NGSP units), or HbA1c levels may be reported as millimoles of HbA1c per mole of haemoglobin (mmol/mol, IFCC units). This assay reports HbA1c levels as %HbA1c. Healthy %HbA1c levels are less than 5.7% or 38.8 mmol/mol (2).

### ELEVATED HbA1c AND DIABETES

Values between 5.7% and 6.4% indicate prediabetes, which is associated with an increased risk of diabetes. Values of 6.5% and higher support a diabetes diagnosis. The recommended goal for diabetic adults is to maintain a %HbA1c level of less than 7.0%. These values were obtained from the Alinity c Hemoglobin A1c package insert (3), which follow recommendations from the American Diabetes Association (2).

Higher HbA1c levels are associated with an increased risk of diabetic health complications, such as retinopathy, heart failure, and peripheral vascular disease (4). Diabetic individuals generally require an HbA1c test every 3-12 months to ensure that their blood sugar is staying within the target range (<7.0% HbA1c) (2).

### ELEVATED HbA1c AND CARDIOVASCULAR HEALTH

Higher levels of HbA1c are associated with an increased risk of peripheral arterial disease, even among patients without diabetes (5).

In the Framingham Heart Study, HbA1c was significantly related to prevalent cardiovascular disease among women but not men. HbA1c was also related to hypertension and to the ratio of total to high-density lipoprotein cholesterol levels (6).

### FACTORS INFLUENCING HbA1c ANALYSES

Various different factors may lead to misleading %HbA1c results, including diseases that affect haemoglobin (e.g. anemia), specific supplements (e.g. vitamins C and E), pregnancy, significant blood loss, high cholesterol, kidney and liver disease (7).

### LOWERING HbA1c

A combination of diet, exercise, and medication can lower HbA1c levels. Several studies, including the Diabetes Control and Complications Trial (8), have demonstrated that improving HbA1c by 1% for people with diabetes (type 1 or type 2) reduces the risk of microvascular complications by 25%.

### TEST PROCEDURE

Correct specimen collection and handling is required for optimal assay performance.

This test requires a blood sample from a finger prick. All supplies for sample collection are provided in this kit. First wash and dry hands. Warm hands aid in blood collection. Clean the finger prick site with the alcohol swab and allow to air dry. Use the provided lancet to puncture the skin in one quick, continuous and deliberate stroke. Wipe away the first drop of blood. Massage hand and finger to increase blood flow to the puncture site. Angle arm and hand downwards to facilitate blood collection on the fingertip. Drip blood onto the blood collection card or into the microtainer tube.

Avoid squeezing or 'milking' the finger excessively. If blood flow stops, perform a second skin puncture on another finger, if more blood is required. Do not touch the fingertip.

Dispose of all sharps safely and return sample to the laboratory in the provided prepaid return shipping envelope.

Upon receipt at the laboratory, the blood sample is analyzed by the fully automated Alinity c Hemoglobin A1c assay on the Alinity ci series analyzer. This assay determines HbA1c levels using enzymatic methodology, where the concentration of HbA1c in the blood sample is proportional to the hydrogen peroxide levels produced in the final step of a complex multi-step analysis.

### TEST INTERPRETATION

This assay will provide an accurate HbA1c level for the tested blood specimen. Healthy HbA1c levels in adult serum are < 5.7%, prediabetes levels are 5.7% - 6.4%, and diabetic levels are ≥ 6.5%. These values were obtained from the Alinity c Hemoglobin A1c package insert (3), which follow recommendations from the American Diabetes Association (2).

### DISCLAIMERS/LIMITATIONS

Medications, hematocrit disorders, chronic liver and kidney disease, and abnormal amounts of fetal hemoglobin (HbF) can affect HbA1c results. In addition, HbA1c levels are decreased in cases of shortened red blood cell survival, including due to hemolytic anemia, sickle cell disorders, pregnancy, and significant blood loss. Hence, this assay cannot be used to diagnose diabetes in individuals from each of these categories.

These results should be interpreted in conjunction with other laboratory and clinical information.

Additional testing is recommended if HbA1c levels are inconsistent with clinical evidence.

Correct specimen collection and handling is required for optimal assay performance.

Interferences from medication or endogenous substances may affect results.

Hematocrit disorders may interfere with assay results.

HbA1c levels are decreased in cases of shortened red blood cell survival, including due to haemolytic anemia, sickle cell disorders, pregnancy, and significant blood loss. Hence, this assay cannot be used to diagnose diabetes in individuals from each of these categories.

Severe chronic hepatic and renal disease, and malignancies may interfere with this assay.

This assay should not replace glucose testing in patients with Type 1 diabetes, pediatric patients, or pregnant women.

Abnormal amounts of fetal hemoglobin (HbF) will interfere with this assay.

## REFERENCES

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