

## **Estimated Average Glucose (eAG): an alternative to A1C**

This Q&A describes a new term for describing diabetes control, “estimated average glucose”, eAG. eAG correlates directly to A1C, which has been the standard measure of diabetes control for many years.

### **What is A1C?**

The A1C (*pronounced A-one-C*) test, also known as glycated hemoglobin or HbA1c, measures average blood glucose control for approximately the 3 months. The results can help health care providers – and their patients – know if the diabetes treatment plan is working or if adjustments to treatment are needed.

A1C is measured by a simple blood test performed in a laboratory. The American Diabetes Association recommends that most people with diabetes have their A1C level checked at least twice a year.

The American Diabetes Association recommends that people with diabetes strive for an A1C goal of less than 7%. An A1C for a person *without* diabetes is approximately 4-6%.

### **Why is understanding average blood glucose control important in the management of diabetes?**

In 1993, when the landmark Diabetes Control and Complications Trial (DCCT) was completed, the importance of A1C as an indicator of risks for the complications of diabetes, such as blindness, kidney disease and nerve damage was firmly established. The DCCT demonstrated that keeping A1C closer to normal reduces the risk for diabetes-related complications. As A1C increases, so does the risk of complications.

In 1994, the American Diabetes Association began recommending specific A1C treatment goals based on the results of the DCCT. From that time on, the goal for most people with diabetes has been less than 7%.

### **What is the difference between A1C and the blood glucose measure obtained through daily self-monitoring?**

A1C results, which tend to be measured at least 2 times a year as part of a visit with the doctor, measure average blood glucose control over the past 2 to 3 months. Results from the A1C test are reported in percentage points (i.e., A1C of 7%).

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When people with diabetes test their blood glucose through daily self-monitoring, those results are reported in different units – mg/dl (i.e., 170 mg/dl). They represent the level of glucose in the blood at that moment in time, but do not give any indication of what the level is at other times of day.

### **Why is daily self-monitoring of blood glucose so important?**

Although the A1C test is an important tool, it can't replace daily self-monitoring of blood glucose (SMBG). A1C tests don't measure a person's day-to-day control. People with diabetes can't adjust their insulin on the basis of their A1C tests. That's why blood glucose checks and log results are so important to staying in good control.

The A1C test alone is not enough to measure good blood glucose control. But it is a good resource to use along with your daily blood glucose checks, to work for the best possible control.

### **What is the A1C-Derived Average Glucose (ADAG) Study and why was it conducted?**

The A1C-Derived Average Glucose (ADAG) Study is an international study sponsored by the American Diabetes Association (ADA), European Association for the Study of Diabetes (EASD), and International Diabetes Federation (IDF). It was conducted in response to the introduction of a new worldwide method of standardization of the A1C assay that would result in values that are 1.5-2 percentage points lower than current standards. It was felt that this change would cause considerable confusion for patients and health care providers.

The objective of the ADAG Study was to define the mathematical relationship between A1C and estimated average glucose (eAG) and determine if A1C could be reliably reported as eAG, which would be in the same units as daily self-monitoring.

### **How was the ADAG Study conducted?**

Five hundred seven people, including 268 patients with type 1 diabetes, 159 with type 2 diabetes, and 80 people without diabetes were recruited from 10 international centers.

A1C was measured using a combination of continuous glucose monitoring and frequent finger stick glucose measurements similar to the way in which people with diabetes check their diabetes control at home by self-monitoring of blood glucose (SMBG).

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By comparing the measurement of A1C with the average glucose levels, study investigators were able to derive an equation so that A1C levels can be interpreted accurately as an average glucose level or eAG.

### What is estimated Average Glucose (eAG) and why is this measure important?

The ADAG Study establishes what has long been assumed but never demonstrated... that A1C does represent average glucose over time. With that relationship demonstrated and defined, health care providers can now report A1C results to patients in the same units that they are using for self-monitoring (i.e., mg/dl) which should benefit clinical care.

*See chart below for a comparison of A1C (%) and average glucose levels (mg/dl)*

### Comparison of A1C and eAG levels

A1C %	eAG (mg/dl)	eAG (mmol/l)
6%	126	7.0
6.5%	140	7.8
7%	154	8.6
7.5%	169	9.4
8%	183	10.1
8.5%	197	10.9
9%	212	11.8
9.5%	226	12.6
10%	240	13.4

**Why is the chart in ADA's Standards of Care showing a correlation between A1C and mean glucose levels slightly different from the correlation published with the ADAG results (as above)**

The chart published in the ADA's Standards of Care is based on a study that analyzed data collected during the DCCT, which included quarterly A1C tests and 7-point glucose measurements in 1,400 type 1 diabetes patients. The International A1C-

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Derived Average Glucose (ADAG) Study involved people with type 1 and type 2 diabetes as well as people without diabetes, and took advantage of the development of continuous glucose monitors, as well as patients making traditional glucose checks, to generate a much larger pool of data. Both studies showed a linear relationship between A1C and average glucose; the ADAG study presents a more refined and accurate formula describing that relationship, and the ADA's Standards of Care will adopt the new correlation. The formula describing the relationship is:  $28.7 \text{ times A1C minus } 46.7 = \text{eAG}$ .

### **How will this new terminology, eAG, help health care providers and their patients?**

Reporting glucose control as 'average glucose' will assist health care providers and their patients in being able to better interpret the A1C value in units similar to what patients see regularly through their self-monitoring.

Part of the logic for choosing the term "eAG" is that the medical community recently adopted another new term, eGFR, for estimated glomerular filtration rate, which was introduced as an easier to understand measure of kidney function than the established method of measuring creatinine levels to assess kidney function. The hope is that the growing acceptance of eGFR will help spur the adoption of the similar eAG.

The American Diabetes Association (ADA), European Association for the Study of Diabetes (EASD), and International Diabetes Federation (IDF) will be working together to conduct educational efforts to make both patients and providers aware of this new terminology, and help to understand the relationship between A1C and eAG.

### **Many patients who practice SMBG already see an "average glucose" on their blood glucose meters. Is eAG the same thing?**

No, an eAG value is unlikely to match the average glucose level shown on a person's meter. Because people with diabetes are more likely to test more often when their blood glucose levels are low---first thing in the morning, and before meals---the average of the readings on their meter is likely to be lower than their eAG, which represents an average of their glucose levels 24 hours a day, including post-meal periods of higher blood glucose when people are less likely to test. One advantage of using eAG as a measure of glucose control is that it will help patients more directly see the difference between their individual meter readings and how they are doing with their glucose management overall.