Technical Brief

Estimated Average Glucose (eAG)

Background Information

The estimated average glucose (eAG) is an estimate of a patient's average glucose level over the preceding 2-3 months, based on measurement of the patient's glycosylated hemoglobin A (HgbA1c). HgbA1c is reported as a %, based on the amount of a particular glycosylated hemoglobin A species relative to total hemoglobin A.

The "A1c-Derived Average Glucose" (ADAG) study showed the relationship between average glucose levels and HgbA1c in both diabetic and non-diabetic patient populations. This is the largest and most comprehensive study to date to examine this relationship. The results from the study established the mathematical relationship between measured HgbA1c levels and long-term average glucose levels. The American Diabetes Association (ADA) and the American Association of Clinical Chemistry (AACC) recommend that clinical laboratories calculate and report eAG along with HgbA1c results.

The Diabetes Control and Complications Trial (1993) was a landmark study that showed the relationship between elevated HgbA1c levels and increased risk of complications in patients with diabetes, including neuropathy, renal disease, and blindness. Efforts to standardize HgbA1c measurements led to the establishment of the National Glycohemoglobin Standardization Program (NGSP), which now certifies laboratories and/or instrument manufacturers engaged in HgbA1c measurement. This standardization allowed for national and international guidelines to be established for diabetic patients whose glucose control is monitored through HgbA1c measurements. The HgbA1c level is regarded as a better indicator/predictor of glucose levels/complications than blood glucose measurements (both self-monitoring and laboratory-based testing). Blood glucose measurements reflect transient (short-term) levels and are subject to variability due to testing time of day, relationship to fasting interval, etc. Additionally, eAG is reported in the same units as glucose, which patients are accustomed to viewing on glucose meters or in lab reports. Thus, a more intuitive understanding of long-term glucose control can be communicated through eAG reporting.

Most clinicians and their diabetic patients are already calculating or looking up eAG levels based on HgbA1c when evaluating glucose control or planning changes to medication regimens. These groups are already familiar with the concept of eAG, and the management of these patients' diabetes will simply be more straightforward when eAG level is directly provided in the lab report.

Clinical Indications

Monitoring long-term glucose control in diabetic patients

Results/Interpretation

Currently, eAG reference ranges and cutoff values are not established. This is because the eAG is directly calculated from the HgbA1c measurement, which has established reference ranges based on the patient population and type of assay/instrument. A typical HgbA1c reference range is 4-6%, corresponding to eAG levels of 68-126 mg/dL. The ADA has endorsed HgbA1c, and, by extension eAG, for establishing a diagnosis of diabetes.

Methodology

The calculation of eAG is based on the relationship derived in the ADAG study, using NGSP referenced HgbA1c levels:

$$\text{eAG (in mg/dl)} = 28.7 \times \text{A1C(\%)} - 46.7$$

The eAG(calc) is reported on the line below the HgbA1c level and has an accompanying comment:

eAG: (Estimated average glucose) is a calculated value from HgbA1c and is representative of the average blood glucose level in the last 2-3 month period.

eAG is automatically reported with each HgbA1c.

Limitations of the Assay

Numerous conditions that impact the validity of HgbA1c levels as an indicator of glucose control are known, including various types of anemia, certain hemoglobinopathies, and use of antioxidants. These conditions would similarly impact eAG, and make it not representative of actual long-term glucose levels. Clinicians using HgbA1c levels to track glucose control are aware of these limitations, and should exercise similar judgment in interpreting eAG levels. Alternative measures for evaluating glucose control, such as continuous glucose monitoring, or measuring fructosamine levels, are available for those patients in which HgbA1c/eAG is not a useful marker of glucose control.

Related Tests

eAG is calculated from HgbA1c levels, which must be ordered for eAG to be reported.

Suggested Readings

Nathan DM, Kuenen J, Borg R, *et al*. for the A1C-Derived Average Glucose (ADAG) Study Group. Translating the A1C assay into estimated average glucose values. *Diabetes Care*. 2008;31:1473-1478.

The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med*. 1993;329:977-986.

Consensus committee: consensus statement on the world-wide standardization of the hemoglobin A1C measurement: the American Diabetes Association, European Association for the Study of Diabetes, International Federation of Clinical Chemistry and Laboratory Medicine, and the International Diabetes Federation. *Diabetes Care*. 2007;30:2399-2404.

Saudek CD, Herman WH, Sacks DB, *et al*. A new look at screening and diagnosing diabetes mellitus. *J Clin Endocrinol Metab*. 2008;93:2447-2453.

http://www.aacc.org/gov/gov_affairs/positions/pos_stat_09/Documents/AACCPosition-eAG.pdf

http://api-pt.com/pdfs/2009Cchem.pdf

Technical Information Contact:

Anne Bordner Blank, MT(ASCP)
216.444.2173
bordnea@ccf.org

Scientific Information Contact:

Sihe Wang, PhD
216.445.2634
wangs2@ccf.org