



Educational Discussion: Hemoglobin A1c

2017-B Hemoglobin A1c (GH5-B)

GH-06, GH-07, GH-08, GH-09, and GH-10 samples were prepared from pooled whole blood obtained from healthy or diabetic individuals. The target values were determined from the means of all results from seven National Glycohemoglobin Standardization Program (NGSP) Secondary Reference Laboratories (SRLs). Each laboratory analyzed each sample in triplicate on two separate days. These NGSP Network Laboratories use methods that are calibrated and traceable to the method used in the Diabetes Control and Complications Trial (DCCT). Comparison to the NGSP Network allows both manufacturers and clinical laboratories to trace their glycated hemoglobin results to the DCCT. The target HbA1c values for the survey are as follows: GH-06, 7.42%; GH-07, 5.2%; GH-08, 8.31%; GH-09, 10.33% and GH-10, 5.87%.

The Survey uses an accuracy based evaluation against the NGSP reference method targets with an acceptable limit equal to $\pm 6\%$ of the target value. Because the PT samples are prepared from human whole blood, the bias observed for the PT samples is expected to reliably reflect the bias that exists for patient samples analyzed with the same method. The percentage is a mathematical fraction, not the HbA1c reporting unit. For example, the acceptable range for GH-07, which has a HbA1c value of 5.2%, would be HbA1c values between 4.8 and 5.6%.

For the five specimens, the pass rates vary considerably depending on the HbA1c method (data for all methods $n \geq 10$ are summarized in Table 1). While the overall pass rate ranged from 95.6 to 97.8%, depending on the target value, the lowest pass rate was 76.2%. Nevertheless, some methods were able to achieve 100% (or close to 100%) pass rates for all five samples.

Table 1



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Specimen	NGSP Target (% HbA1c)	Acceptable Range	Pass rate % (Low/High)	Cumulative Pass Rate %
GH-06	7.42	6.9-7.9	87.7/100.0	95.7
GH-07	5.20	4.8-5.6	81.0/100.0	97.4
GH-08	8.31	7.8-8.9	91.7/100.0	97.8
GH-09	10.33	9.7-11.0	81.3/100.0	95.6
GH-10	5.87	5.5-6.3	76.2/100.0	97.0

Pass rates listed are for methods with a peer group $n \geq 10$.

Examination of the HbA1c results obtained by participants in the Survey reveals that in general the mean values measured by the participants did not differ markedly from the values determined by the NGSP Secondary Reference Laboratories. None of the means for the laboratory analyzers differed from the target value by more than 0.4% HbA1c. (A change of 0.5% HbA1c is considered by many to be a clinically significant difference.) The method-specific HbA1c means for GH-08 (HbA1c target value 8.31%) exhibited the least variation, ranging from 8.13% to 8.45% HbA1c (these are differences of -2.2 and +1.7%, respectively, from the target value). The method-specific means for GH-06 (HbA1c target value 7.42%) ranged from 7.21% to 7.71% HbA1c (differences of -2.8 and +3.9%, respectively, from the target value). GH-07 (HbA1c target value 5.2%) had method-specific means ranging from 4.87% to 5.45% HbA1c (differences of -6.3 and +4.8%, respectively, from the target value). GH-09 (HbA1c target value 10.33%) had method-specific means ranging from 9.95% to 10.63% HbA1c (differences of -3.7 and +2.9%, respectively, from the target value). GH-10 (HbA1c target value 5.87%) had method-specific means ranging from 5.56% to 6.09% HbA1c (differences of -5.3 and +3.75%, respectively, from the target value). Abbott Architect c System, Tosoh G8 Automated HPLC and Trinity Biotech Premier Hb9210 HPLC had the lowest CVs ($\leq 2.0\%$) for all five samples. By contrast, Siemens Dimension RxL had CVs $>3.5\%$ for three samples. No other method had CVs $>3.5\%$ for more than one sample. Guidelines from The National Academy of



Clinical Biochemistry and the American Diabetes Association recommend an inter-laboratory CV<3.5% (Clin Chem 2011; 57:e1-e47 and Diabetes Care 2011; 34:e61-99). Most methods were able to achieve this criterion. Roche cobas c311 had the lowest mean value for three samples.

In addition to the tables, the data obtained for each method (with a peer group $n \geq 10$) are also presented in the style of box-and-whisker plots (Fig. 1A-E). Each method is listed individually, with the number of participants using that method in parentheses after the name of the method. The individual lines extend from the minimum to maximum difference, expressed as a percentage from the target value (the percentage is a mathematical fraction). The thicker line indicates the distribution of the middle 90% of values. The grey shaded area represents the evaluation limit, i.e., $\pm 6\%$ from the target. The diamond is the median for the particular method. Outliers were excluded. The presentation allows rapid visualization of bias [how far the diamond (median) is from zero], imprecision (length of the line) and the number of laboratories that failed (those that lie outside the shaded area) for each method. This feature provides additional detailed information that should be useful to individual laboratories to assess their method and compare it to both their peers and to other methods.

Manufacturers of methods that have the means furthest from the reference value and those with the largest imprecision are encouraged to improve their performance, especially those methods that consistently exhibit large bias and/or large CVs. This is particularly important in the clinically relevant HbA1c ranges ($\sim 5.5\%$ to 8%).

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Chemistry Resource Committee