Automatic mixing by the Radiometer ABL800 FLEX blood gas analyzer is superior to manual mixing for producing a homogeneous specimen.

Christopher Parker[1] and David G. Grenache[2]

[1]McLendon Clinical Laboratories, University of North Carolina Hospitals, Chapel Hill, NC

[2]University of North Carolina School of Medicine, Department of Pathology & Laboratory Medicine, Chapel Hill, NC

Introduction

Whole blood specimens used for blood gas analysis must be thoroughly mixed prior to analysis to produce accurate results. This is particularly important for the quantification of total hemoglobin (tHb) because specimens in which red blood cells have settled can produce spurious results.

Producing a homogeneous blood gas specimen presents a unique challenge because of the requirement that there be no dead space in the syringe barrel to prevent contamination of the specimen with atmospheric air. The absence of a dead space can impair the efficient mixing of the specimen.

Although it is recommended that syringe specimens be mixed by gentle rotation for a minimum of two minutes prior to analysis, this practice is inconsistently utilized and may be insufficient.

The ABL800 FLEX (Radiometer America Inc., Westlake, OH) is a fully automated blood gas analyzer that automatically mixes whole blood specimens through the use of a rotating internal magnet that moves a metal mixing ball inside the barrel of a safePICO blood gas syringe (Radiometer America Inc.).

Objectives

1. To determine if the automatic mixing feature of the ABL800 FLEX is a suitable alternative to manual mixing using tHb as an indicator of homogeneity.
2. Estimate the systematic error in tests performed by the ABL800 FLEX using an ABL700 (Radiometer America Inc.) analyzer as the reference instrument.

Methods

Patients and Specimens

After approval from the institution's IRB, 97 sets of 4 arterial whole blood specimens were collected from 54 adult patients: 2 specimens into standard blood gas syringes and 2 into safePICO syringes.

Mixing study

45 sets of specimens were stored horizontally at room temperature for 10, 20, or 30 minutes prior to analysis. Following incubation, standard syringe specimens were hand-mixed by technologists and analyzed on the ABL700 blood gas analyzer. Specimens collected into safePICO syringes were automatically mixed and analyzed by the ABL800 FLEX.

Comparison of methods study

52 sets of specimens were analyzed immediately upon receipt in the laboratory. Duplicate testing on each instrument was accomplished by analyzing, in singlicate, the two specimens collected into standard syringes on the ABL700 and the two specimens collected into safePICO syringes on the ABL800 FLEX. Three sets of specimens were excluded due to an inhomogeneous sample error reported by the ABL800 FLEX for one or more of the specimens in the set. Outliers were identified and excluded in accordance with guidelines described by the Clinical Laboratory Standards Institute.

Statistical analyses

Mixing study data were evaluated with the F statistic by comparing the variances of the total hemoglobin differences determined between specimens collected into standard or safePICO syringes. Deming regression was used to estimate the linear relationships between analytes measured on the ABL700 and the ABL800 FLEX.

Results

See table and figures to the right.

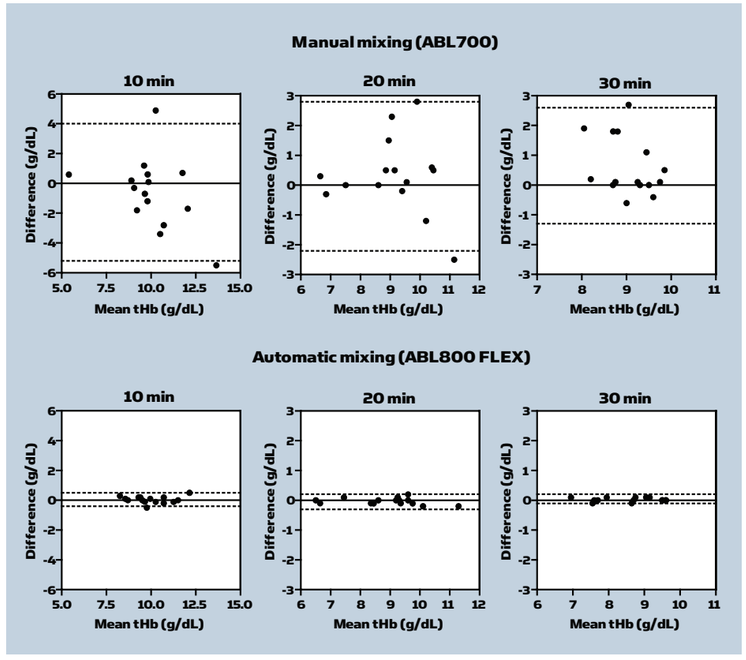

Figure 1. Bland-Altman plots reveal that manual mixing of specimens produces significantly more variation in tHb measurements compared to automatic mixing after specimen storage for 10, 20, and 30 minutes ($p<0.0001$). The dotted lines define the 95% confidence interval.

Conclusions

Manual mixing of a syringe is insufficient to reliably produce a homogeneous specimen. Automatic mixing by the ABL800 FLEX consistently produces a homogeneous specimen. The ABL800 FLEX blood gas analyzer shows very good analytical agreement and correlation with the ABL700.

Analyte	N (sets of 4)	Range	Slope (95% CI)	Intercept (95% CI)	Sy.x	R
pH	47	7.118-7.502	1.023 (1.004 to 1.043)	-0.173 (-0.315 to -0.032)	0.007	0.996
PCO2 (mm Hg)	48	30-65	1.065 (1.027 to 1.103)	-1.9 (-3.5 to -0.3)	1.4	0.985
PO2 (mm Hg)	46	54-570	0.936 (0.908 to 0.965)	6.1 (0.67 to 11.6)	14.1	0.990
Na+ (mmol/L)	48	131-150	1.058 (0.981 to 1.134)	-9.3 (-20.0 to 1.3)	1.4	0.935
K+ (mmol/L)	48	2.7-5.6	1.023 (0.968 to 1.078)	0.05 (-0.16 to 0.26)	0.16	0.966
Ca++ (mg/dL)	48	3.2-5.3	1.034 (0.974 to 1.094)	-0.18 (-0.46 to 0.10)	0.12	0.959
Glu (mg/dL)	49	59-300	0.961 (0.944 to 0.979)	0.4 (-2.5 to 3.2)	5.0	0.996
Lac (mmol/L)	49	0.5-7.6	0.906 (0.890 to 0.921)	0.0 (-0.04 to 0.03)	0.09	0.996
tHb (g/dL)	45	6.8-12.8	1.033 (1.0 to 1.067)	-0.35 (-0.69 to 0.0)	0.3	0.988

Table 1. Deming regression analysis of tests analyzed on the ABL800 FLEX compared to the ABL700 blood gas analyzer reveal very good agreement between the two instruments in all measured parameters. All observed differences were clinically insignificant.

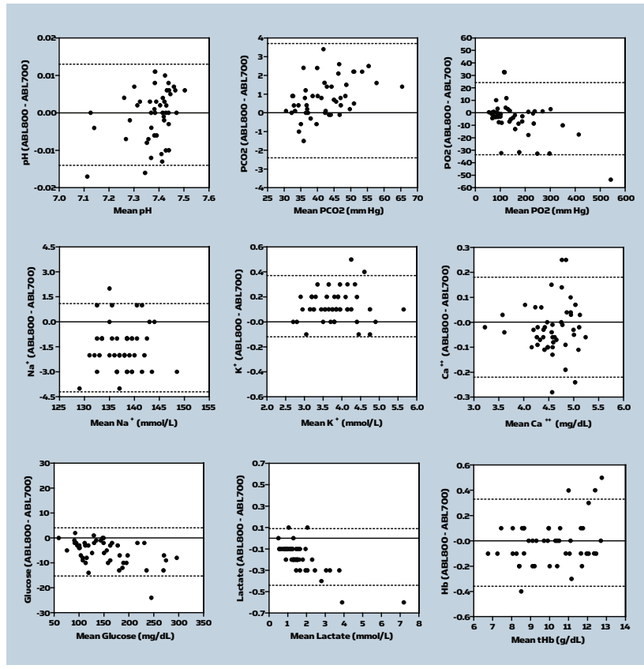

Figure 2. Bland-Altman plots comparing analytes quantified on the ABL700 and ABL800 FLEX blood gas analyzers. The dotted lines define the 95% confidence interval.

Presented at the AACC 2006 Annual Meeting and Clinical Lab Exposition, July 26, 2006.