

A Comparison of Non-Invasive Hemoglobin Measurements to Laboratory Hemoglobin and to Red Blood Cell Volume-Derived Hemoglobin

Shifflette V., Stahler P., Inouye D., Hayashi M., Pei K., Takiguchi S., Machi R., Takanishi D., Yu M. Crit Care Med; 40(12):1071

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Introduction

Recent advances in Pulse CO-Oximetry permit continuous non-invasive monitoring of hemoglobin (Hgb) while simultaneously providing oxygen saturation data (Masimo Corp, Irvine, CA). Previous studies have validated the relationship between non-invasive Hgb (Sp-Hgb) and Hgb measured by conventional laboratory analyzers (Lab-Hgb). Lab-Hgb and Hematocrit (Hct) reflect red cell volume (RBCV) in relationship to plasma volume (PV) and may be falsely high (hemoconcentration) or falsely low (hemodilution) depending on deviations in PV. Red blood cell volume is more accurately determined by using the Blood Volume Analyzer (BVA-100, NY, NY). This study assessed the relationships between Sp-Hgb to Lab-Hgb, and Sp-Hgb to Hgb derived from Blood Volume analysis (BV-Hgb). *Hypothesis:* Sp-Hgb measurements are equivalent to Lab-Hgb and BV-Hgb.

Methods

In this prospective observational study in critically ill surgical patients, not actively receiving blood transfusions, simultaneous measurement of Sp-Hgb, Lab-Hgb, and BV-Hgb was performed. BVA-100 uses radiolabeled iodine injected into a patient with 5 subsequent blood draws to correct for albumin transudation in measuring a patient's PV. Simultaneous Lab Hct (RBCV/RBCV+PV) allows calculation of RBCV. A "Corrected Hct" is the Hct value if the PV was adjusted to the patient's normal Blood Volume. BV-Hgb is derived from the Corrected Hct value and may best reflect RBCV without influence from PV, which avoids the limitations of hemodilution or hemoconcentration.

Results

34 patients generated 35 simultaneous data points. Demographics were: 66 +/- 17 yrs of age; 20 males:14 females; APACHE II 22 +/- 6; 23 septic shock/severe sepsis, 8 cardiac failure, 22 respiratory failure patients. Sp-Hgb to BV-Hgb showed a significant correlation, $r=.48$ ($p=.004$), $R^2=.23$ ($p=.004$), Precision of 2.2 g/dL and Bias -0.7 g/dL. Sp-Hgb to Lab-Hgb showed an r value of 0.36 ($p=.039$), $R^2=.09$ ($p=.076$), Precision of 2.1 g/dL and Bias +1.05 g/dL.

Conclusions

Despite no differences in the bias and precision between Sp-Hgb vs BV-Hgb and Lab-Hgb, the correlation was better with BV-Hgb suggesting that the non-invasive Hgb measurements take into better account the changes in plasma volume of the patients in this cohort.