

A COMPARISON OF HEMOGLOBIN MEASURED BY CO-OXIMETRY AND CENTRAL LABORATORY DURING MAJOR SPINE FUSION SURGERY

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Introduction

- Transfusion of red blood cells remains the first line therapy for treating hypoxia due to anemia.
- Transfusion thresholds, determined by patient comorbidities and evidence of active bleeding, are used to determine when inadequate oxygen delivery may be occurring that requires treatment with RBCs.
- There are a multitude of factors affecting the accuracy of hemoglobin concentration measurements, including the type of measurement device and the laboratory methodology used.

Hypothesis

- This study aims to evaluate if the hemoglobin concentration obtained by means of arterial blood gas (ABG) co-oximetry and central laboratory techniques (CBC) clinically correlate when using simultaneous measurements of hemoglobin concentration obtained during complex spine fusion surgery.
- We hypothesized that the two techniques would produce measurements that varied more than the stated resolution of 0.1 g/dL, especially in the range of hemoglobin values (e.g., 7-10 g/dL) where most transfusion decisions are made.

Methods

- 348 patients who underwent spinal fusion of greater than 3 bony levels between September 2006, and September 2010, with concurrent ABG and CBC samples were identified.
- The mean difference between pairs of measured hemoglobin values was determined using limits of agreement analysis. Error grid analysis was used to delineate correlation of samples in relation to hemoglobin values within the range considered for transfusion.

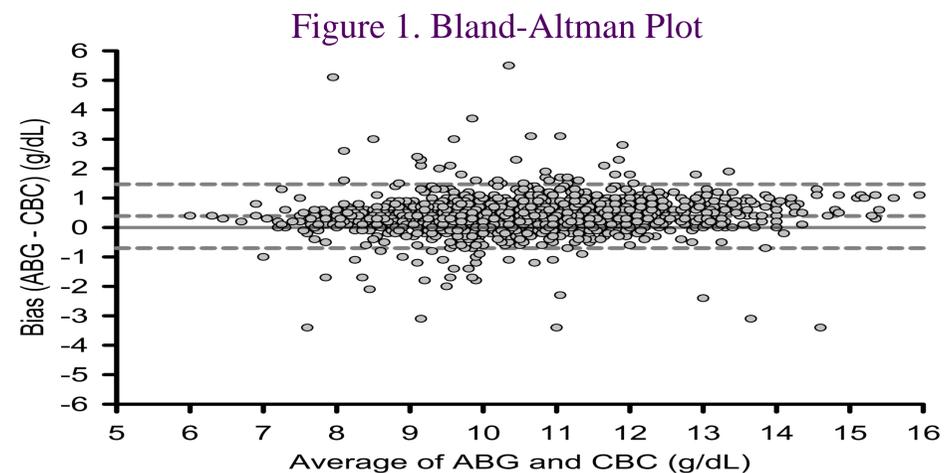
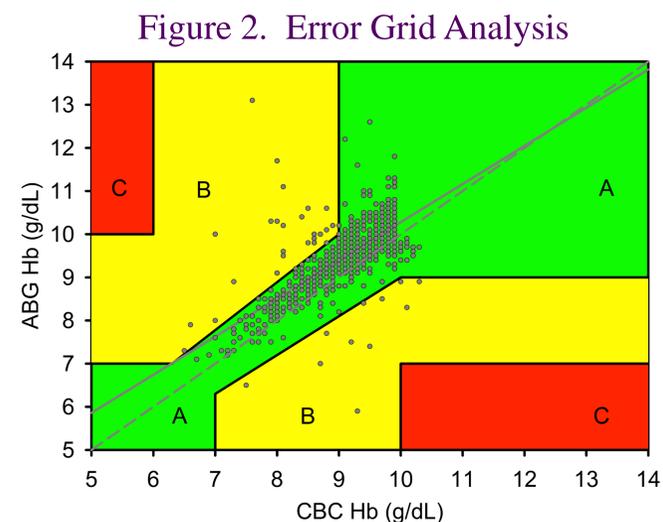


Figure 1. A Bland-Altman plot corrected for repeated paired measures of hemoglobin concentration with co-oximetry (ABG) and central laboratory (CBC) in multiple patients. The mean difference (bias of ABG - CBC) was 0.39 g/dL (center dashed line) with the 95% limits of agreement between -0.70 and 1.47 g/dL (outer dashed lines).



Hemoglobin error grid analysis for paired hemoglobin values measured by co-oximetry (ABG Hb) versus concurrent samples measured via central laboratory (CBC Hb) with a line of unity (dashed) representing ideal correlation of sampling methodology and the regression line (solid) demonstrating agreement for the full dataset (Cohen's K = 0.69, 99% CI 0.66 to 0.72). (a) Zone A (green) represents the value ranges where the difference in hemoglobin measurements is clinically acceptable in accordance with ASA guidelines for perioperative transfusion to goal hemoglobin > 7 g/dL and < 10 g/dL. Zone B (yellow) represents the area where clinical decisions may be influenced by the differences in hemoglobin measurements. Zone C (red) delineates the area where paired sample measurements would be clinically unacceptable. (b) The error grid analysis focused on the isthmus for the clinical range of hemoglobins from 7 – 10 g/dL and delineating only moderate agreement between ABG and CBC measurements with the gray solid regression line (Cohen's K = 0.46, 99% CI 0.41 to 0.50). Hemoglobin error grid analysis for paired hemoglobin values measured by co-oximetry (ABG Hb) versus concurrent samples

Results

Table 1: Absolute difference in Hgb measures between co-oximetry and central lab(ABG-CBC)

| | <0.5g/dL | 0.5-1.0g/dL | 1.1-1.5g/dL | 1.6-2.0g/dL | >2.0g/dL |
|-------|--------------|-------------|-------------|-------------|-----------|
| N (%) | 1017 (55.5%) | 690 (37.7%) | 79 (4.3%) | 22 (1.2%) | 24 (1.3%) |

- Limits of agreement analysis correcting for repeated observations in multiple patients demonstrated that the mean difference between the pairs of measured hemoglobin values (i.e., bias, ABG-CBC) was 0.39 g/dL (95% CI 0.36 to 0.41 g/dL, Fig 1)
- Error grid analysis demonstrated that 41 pairs (2.2%) were outside of Zone A (Fig 2). All but one of these paired measurements was in Zone B. There were 765 pairs (41.8%) of measured hemoglobin values where at least one of the pair of measured hemoglobin values was between 7 and 10 g/dL (Fig 2)
- There was only moderate agreement between the CBC and ABG hemoglobin values for all values in this region (Cohen's $\kappa = 0.46$, 99% CI 0.41 to 0.50, Fig 2, gray solid regression line)

Discussion and Conclusions

- The current study does not identify a gold standard of hemoglobin measurement
- Hemoglobin measurement by co-oximetry (ABG) and central laboratory analysis (CBC) are not interchangeable
- Further studies investigating novel point-of-care and continuous hemoglobin monitoring technology should be consistently compared to either ABG or CBC alone, and attempt to focus on hemoglobin values between 7 and 10 g/dL
- During management of acute blood loss, particularly when implementing a restrictive approach, consideration should be given to the mean difference in hemoglobin values between these two commonly employed measurement techniques