

Evaluation of Pulse CO-Oximetry to Non-Invasively Monitor Hemoglobin Concentration in Pediatrics

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Introduction

The Masimo Rainbow SET Pulse CO-Oximeter (Masimo Corporation, Irvine, CA) is FDA approved to noninvasively and continuously monitor blood total hemoglobin concentration (SpHb). By monitoring SpHb, anesthesiologists are alerted sooner to changes in hemoglobin concentration than blood drawing methods, facilitating clinical transfusion decisions, decreasing the number of blood draws, and evaluating the response to transfusion, especially in pediatrics, in whom surgical blood loss is a greater proportion of total blood volume and cardiovascular changes occur more abruptly. In this single center prospective study, we evaluated the accuracy of SpHb measurements in comparison with the point of care analysis (i-STAT) and standard laboratory measurement (tHb) in infants, children, and adolescents.

Methods

After IRB approval and parents/patient consent, patients weighing greater than 3 kg and age to 21 years old undergoing a surgical procedure with a potential for blood loss > 20% of total blood volume were studied (cardiac, orthopedic, craniofacial reconstruction, and major thoracic/abdominal operations). Two adhesive single use sensors (R1 20L weight = 3 to 30 kg or R1 25L weight = > 30 kg, revision E) attached to Masimo Radical 7 (software 7621 and 7801) were placed on the fingers. Blood was drawn to measure tHb (CELL-DYN Sapphire; Abbott Diagnostics, Santa Clara, CA) or i-STAT as clinically indicated. When blood was drawn, SpHb was recorded. Accuracy of SpHb, in-vivo adjusted SpHb (adjSpHb) and i-STAT were evaluated by bias, precision and root square (Arms) against tHb. In-vivo adjusted SpHb was calculated from the bias of the first SpHb against tHb ($\text{adjSpHb} = \text{SpHb} - \text{bias}$). Correlations of changes in SpHb or i-STAT against changes in tHb were determined by regression analysis.

Results

Of the 29 subjects recruited, 5 weighed 3 -9.9 kg, 7 weighed 10 -29.9 kg (children), 7 weighed 30-49.9 kg, and 10 weighed > 50 kg, ranging in age from 2 months to 19 years. A total of 149 paired samples were obtained. Bias, precision, and Arms of SpHb and calSpHb were greater than i-STAT (figure 1). Precision and Arms were in the range of 1.5 gr/dl and 1.1 gr/dl for the SpHb and calSpHb respectively. Precision for SpHb and adjSpHb relative to tHb were similar among the weight groups: 1.8 (<10kg), 1.1 (10-29.9kg), 1.9 (30-49.9kg) and 1.2 (>50kg). Correlation of changes in hemoglobin concentration were similar with i-STAT and adjSpHb (figure 1).

Discussion

The accuracy of SpHb in infants, children, and adolescents from 2 months to 19 years old (5.4 kg to 85 kg) was similar to that reported in adults. In-vivo adjustment improves the accuracy similar to that of i-STAT. During blood loss, changes in adjSpHb are similar to that of tHb and i-STAT. The use of in-vivo adjustment improves monitoring accuracy for transfusion decisions.

References

Jou JF, Wesseler JA, Patino M, Kurth CD. Presentation at Society of Pediatric Anesthesia Meeting, San Diego, 2011. Neuro56

Figure 1. SpHb vs tHb trend plot and summary statistics of all and in-vivo adjusted SpHb measurements and i-STAT values

