Continued Improvement in Absolute and Trend Accuracy of Non-Invasive and Continuous Hemoglobin Monitoring

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Background

Hemoglobin (Hb) measurement informs red blood cell transfusion decision-making with lab Hb considered standard. Excessive sampling is identified as a source of blood loss.[1,2] Noninvasive continuous hemoglobin monitoring with Pulse CO-Oximetry (SpHb) is available. Noninvasive Hb measurement must be within acceptable accuracy limts,[3] and trend the same direction as lab Hb[4] to guide transfusion. We reported on absolute and trend accuracy of revision E SpHb monitoring during major surgery.[5] SpHb technology has undergone several software and sensor revisions, with incremental performance improvement. Our objective was to study absolute and trend accuracy of revision K SpHb adhesive sensor and software.

Methods

Ongoing IRB approved investigator initiated trial. Consenting adult patients scheduled for surgery in which expected blood loss represented a significant portion of estimated blood volume were enrolled. ASA standard monitors and an arterial catheter for blood pressure monitoring and blood sampling were used, as is our practice for these patients. A shielded SpHb Resposable sensor (R2-25, revision K) connected to a Radical-7 Pulse CO-Oximeter (SET sw ver. 7910, Masimo, Irvine CA) was placed on a finger of either hand. SpHb data was continuously recorded to a computer. Time matched SpHb and arterial blood gas CO-Oximetry determined hemoglobin (ABG Hb; ABL-800, Radiometer, Copenhagen, Denmark) samples were obtained at the discretion of the anesthesiologist. SpHb to ABG Hb was analyzed for: bias of SpHb - ABG Hb; linear regression analysis (R2); Bland Altman limits of agreement; and linear regression of paired changes in sequential measurements of SpHb to ABG Hb (JMP 10.0.0, SAS Institute, Cary, NC, USA).

Results

Analysis to date: 2 patients excluded for equipment failure; 100 SpHb-ABG Hb measurements were collected from 22 patients. Compared to results from sensor revision E in the same population,5 Rev K shows improved accuracy (bias -0.47±0.96 g/dL vs Rev E 0.5±1.4g/dL). For 13 pairs when ABG Hb ≤9 g/dL, bias was 0.0±0.4 g/dL. Linear regression analysis (Fig 1) showed higher correlation (R2 0.67 vs Rev E 0.48); Bland Altman plot (Fig 2) showed narrower limits of agreement (-2.4 to 1.4 vs -2.3 to 3.3 g/dL); and regression analysis (Fig 3) of 77 sequential changes showed higher correlation (R2 0.51 vs Rev E 0.31). SpHb increased in only 2 of 20 samples in which the sequential decrease in Hb was >1 g/dL; 1 when ABG Hb <10 g/dL.

Discussion

During major surgery the revision K SpHb sensor showed improved absolute and trend accuracy compared to the revision E sensor. Our data suggests better performance at ABG Hb <9 g/dL, but the small number of values in this range limits analysis. If shown to be accurate in this range, SpHb could contribute to patient safety by providing continuous data on changes in hemoglobin in patients who are more likely to need transfusion if surgical bleeding continues. Further research is needed to determine if this improvement in SpHb is sufficient to guide transfusion decisions during surgery in which large blood loss is likely.

1 *Crit Care Med*. 2003; 31:S715
2 *J Perinatol*. 2005;25:21
3 *Anesth Analg*. 2011;112:858
4 *Ann Emerg Med*. 2011;57:330
5 *Anesthesiology*. 2012;116:65