Hemoglobin Change Measurement Accuracy Obtained from 3 Devices During Surgery

Presented During:

IARS Poster Session (index.cfm?do=ev.viewEv&ev=1720)
Monday, May 8, 2017: 9:30 AM - 11:00 AM
Grand Hyatt Washington
Room: Indpendence A

Abstract Number:

1786

Abstract Type:

IARS Abstract Submission

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Introduction:

Both anemia and transfusion have been associated with morbidity and mortality.[1-4] A patient's clinical condition may dictate red blood cell transfusion decisions, but transfusion decisions are often guided by hemoglobin (Hb) measurements which may lag Hb changes in the patient. Evidence based guidelines provide targets for Hb, but red blood cells are sometimes given to patients before Hb decreases to the target range or continued after Hb has risen above the range.[5, 6] Continuous Hb monitoring may have clinical advantages. A pulse oximetry based monitor that reports continuous pulse oximetry hemoglobin has been tested in a range of surgical settings. Absolute accuracy for point of care Hb monitors have wide limits of agreement,[7-10] but Hb changes (Hb trend) could provide useful clinical information. This study evaluates trend accuracy of Hb monitors during surgery.

Methods:

This collaborative prospective observational study in 3 academic medical centers enrolled adult patients scheduled for surgery with planned arterial catheter placement and continuous SpHb monitoring (Radical-7, Masimo, Irvine, CA, USA; R125, Rev K – same SpHb algorithm as Rev L). When a clinically indicated blood sample was obtained, we recorded SpHb and analyzed each blood sample twice using the same analyzers to determine Clinical Laboratory Hb (tHb; Sysmex 550 or Coulter LH 750), arterial

blood gas co oximeter Hb (ABGHb; Radiometer ABL800; Nova Biomedical CCX or PhOX; Siemens RAPIDLab 1265) and point of care Hb using arterial not capillary finger stick blood (aHQHb; HemoCue HB 301, HemoCue America, Brea, CA, USA). Two-point Bland Altman analysis of tHb was used to establish the minimum Hb change detectable.

We analyzed the correlation of change in tHb to changes in SpHb, ABGHb and aHQHb to assess trend accuracy overall and within defined tHb ranges. Trend bias was assessed; bias within 10% of tHb was considered clinically equivalent. Agreement between increase or decrease in SpHb, ABGHb or aHQHb to tHb increase or decrease was assessed (%; 95% CI).

Results:

Patient characteristics are shown in Table 1. Bland Altman analyses showed tHb change within ±0.25 g/dl and ABGHb or aHQHb changes within ±0.5 g/dl to be within analyzer reliability. Correlations of 416 changes from 135 patients are shown in Table 2. Trend fit was better at tHb up to 10 g/dl (Fig 1); correlation within tHb ranges is shown in Fig 2.

The confidence intervals for the proportion of samples with trend bias within 10% of tHb overlapped for SpHb (372 of 416 trends; 89.4%; 86.1% to 92.2%), ABGHb (391 of 416 trends; 94.0%; 91.3 to 95.9%) and aHQHb (406 of 416 trends; 97.6%; 95.6 to 98.7%). Agreement between trends is shown in Table 3; the 95% CI of increases and decreases overlapped for ABGHb and SpHb, suggesting similar agreement.

Conclusion:

SpHb, ABGHb and aHQHb appear to provide similar intraoperative guidance regarding tHb increase or decrease. Continuous noninvasive SpHb changes larger than ± 0.5 g/dl could provide a reasonable indication for the clinician to obtain a confirmatory blood sample for Hb measurement, but not replace such measurement in guiding transfusion decision making. The transfusion impact of continuous hemoglobin trend monitoring should be studied.

Supported by research grants from Masimo to Loma Linda University, Mayo Clinic in Florida and University of California Irvine.

IARS Abstract Category:

Technology, Computing and Simulation, Equipment Monitoring