Improved Accuracy and Trending of Noninvasive Hemoglobin Measurements with "In Vivo" Adjustment.

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Background

Technology to measure hemoglobin noninvasively via Pulse CO-Oximetry probes has been developed and refined in recent years. The accuracy of this technology has been debated in the literature with several studies claiming clinically acceptable results between noninvasive hemoglobin (SpHb) and hemoglobin obtained via blood sample (tHb). (1,2) One study found earlier versions of this technology "too unreliable" in the emergency room setting. (3) Our study used the latest revision of the Pulse CO-Oximetry probes capable of measuring SpHb (Rev E) and sought to describe the accuracy of the overall intra-operative trend of SpHb values relative to tHB values.

Methods

After IRB approval and informed patient consent, 28 high-risk patients (ASA class 3-4) undergoing elective vascular, neurosurgical, orthopedic, urological or general surgical procedures requiring an arterial line for standard of care monitoring were prospectively enrolled in an observational trial. Two Masimo Rainbow Resposable probes (Rev E) were attached to the middle or ring finger, according to manufacturer's instructions, on both the right and/or left hands of each patient. The probes were covered with ambient shields to prevent optical interference. Continuous SpO2, SpHb, perfusion index, pulse rate and signal quality index were recorded and downloaded to a laptop computer for analysis. SpHb values were compared with tHb values obtained from intra-operative blood samples drawn via arterial line and analyzed by laboratory CO-Oximetry (Siemens Rapid Point 750). Bias and precision of SpHb to tHb measurements were calculated and a trend graph was plotted. Trend analysis was performed by comparing the consecutive changes in tHb values to the consecutive changes in SpHb. The magnitude and direction of the tHb changes were then compared to the SpHb changes. Additionally, SpHb measurements were post-operatively adjusted by the difference between the first pair of time-matched tHb and SpHb values to determine if this adjustment would improve the accuracy.

Results

The bias and precision of SpHb to tHb measurements were -0.2 +/- 0.9 g/dL. After post-operative adjustment, the bias and precision were 0.0 +/- 1.0 g/dL. Of the 172 paired tHb and SpHb data points, 43 tHb values changed by 1g/dL or more relative to the immediately preceding tHb value. Lab value changes of greater than 1 g/dL were accompanied by SpHb changes of comparable magnitude and direction.(Table 1) Graphical analysis of the trend data produced a slope of 1.1 g/dL change of SpHb for every 1 g/dL change in tHb.(Figure 1)

Conclusions

Noninvasive hemoglobin measurement from Pulse CO-Oximetry (SpHb, Rev E) provides clinically acceptable accuracy (within 1 g/dl) compared to laboratory CO-Oximetry (tHb) measured during high risk surgical procedures in patients with co-morbid conditions (ASA 3-4). Accuracy and descriptive statistics improved when each time-matched SpHb value was adjusted

by the magnitude of difference between the first tHb and corresponding SpHb. If this type of adjustment were performed in real time "in vivo" (i.e. intraoperatively), overall accuracy of SpHb values may be further improved. This noninvasive technology may also add value to care in many other clinical locations and scenarios (ICU, PACU, pediatrics, emergency medicine, surgical ward).

References: 1.Miller RM, A&A Apr 2011;112(4):858-863 2.Macknet MR, A&A Dec 2010;111(6):1424-1426 3.Gayat E, Ann Emerg Med Apr 2011;57(4):330-333

Table 1

Trend Sensitivity Data						
tHb Delta		SpHb Delta				
N	Change	<= -1 g/dL	-1 < x < -0.6 g/dL	-0.5 < x < 0.5 g/dL	0.6 > x > 1 g/dL	>= 1 g/dL
33	<= -1.0 g/dL	24	3	6		
10	>= 1.0 g/dL			4	4	2

Figure 1