

Continuous Noninvasive Hemoglobin Monitoring During Complex Spine Surgery

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Background

Monitoring hemoglobin levels in the operating room currently requires repeated blood draws, several steps, and a variable time delay to receive results. Consequently, blood transfusion management decisions may be delayed or made before hemoglobin results become available. The ability to measure hemoglobin continuously and noninvasively may enable a more rapid assessment of a patient's condition and more appropriate blood management. A new technology, Pulse CO-Oximetry, provides a continuous, noninvasive estimate of hemoglobin concentration (SpHb) from a sensor placed on the finger. We evaluated the accuracy of SpHb compared with laboratory CO-Oximetry measurements of total hemoglobin (tHb) during complex spine procedures in patients at high risk for blood loss.

Methods

Patients eligible for the study were undergoing complex spine surgery with planned invasive arterial or central venous monitoring and hourly blood draws for hemoglobin measurement. During each surgery, blood samples were obtained hourly (or more often if clinically indicated) and analyzed by the central laboratory with CO-Oximetry, a standard method of hemoglobin measurement in many hospitals. The tHb measurements were compared with SpHb obtained at the time of the blood draw.

Results

Twenty-nine patients were included in the study. The tHb values ranged from 6.9 to 13.9 g/dL, and the SpHb values ranged from 6.9 to 13.4 g/dL. A total of 186 data pairs (tHb/SpHb) were analyzed; after removal of SpHb readings with low signal quality, the bias (defined as the difference between SpHb and tHb) and precision (defined as 1 SD of the bias) were $-0.1 \text{ g/dL} \pm 1.0 \text{ g/dL}$ for the remaining 130 data pairs. Bland-Altman analysis showed good agreement of SpHb to tHb values over the range of values; limits of agreement were -2.0 to 1.8 g/dL . The absolute bias and precision were $0.8 \pm 0.6 \text{ g/dL}$.

Conclusions

Continuous, noninvasive hemoglobin measurement via Pulse CO-Oximetry demonstrated clinically acceptable accuracy of hemoglobin measurement within 1.5 g/dL compared with a standard laboratory reference device when used during complex spine surgery. This technology may provide more timely information on hemoglobin status than intermittent blood sample analysis and thus has the potential to improve blood management during surgery.