

Evaluation of Noninvasive Hemoglobin Monitoring in Surgical Critical Care

Patients.

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OBJECTIVE: To assess the clinical utility of noninvasive hemoglobin monitoring based on pulse cooximetry in the ICU setting.

DESIGN AND SETTING: A total of 358 surgical patients from a large urban, academic hospital had the noninvasive hemoglobin monitoring pulse cooximeter placed at admission to the ICU. Core and stat laboratory hemoglobin measurements were taken at the discretion of the clinicians, who were blinded to noninvasive hemoglobin monitoring values.

MEASUREMENT AND MAIN RESULTS: There was a poor correlation between the 2,465 time-matched noninvasive hemoglobin monitoring and laboratory hemoglobin measurements ($r = 0.29$). Bland-Altman analysis showed a positive bias of 1.0 g/dL and limits of agreement of -2.5 to 4.6 g/dL. Accuracy was best at laboratory values of 10.5-14.5 g/dL and least at laboratory values of 6.5-8 g/dL. At hemoglobin values that would ordinarily identify a patient as requiring a transfusion (< 8 g/dL), noninvasive hemoglobin monitoring consistently overestimated the patient's true hemoglobin. When sequential laboratory values declined below 8 g/dL ($n = 102$) and 7 g/dL ($n = 13$), the sensitivity and specificity of noninvasive hemoglobin monitoring at identifying these events were 27% and 7%, respectively. At a threshold of 8 g/dL, continuous noninvasive hemoglobin monitoring values reached the threshold before the labs in 45 of 102 instances (44%) and at 7 g/dL, noninvasive hemoglobin monitoring did so in three of 13 instances (23%). Noninvasive hemoglobin monitoring minus laboratory hemoglobin differences showed an intraclass correlation coefficient of 0.47 within individual patients. Longer length of stay and higher All Patient Refined Diagnostic-Related Groups severity of illness were associated with poor

noninvasive hemoglobin monitoring accuracy.

CONCLUSIONS: Although noninvasive hemoglobin monitoring technology holds promise, it is not yet an acceptable substitute for laboratory hemoglobin measurements.

Noninvasive hemoglobin monitoring performs most poorly in the lower hemoglobin ranges that include commonly used transfusion trigger thresholds and is not consistent within individual patients. Further refinement of the signal acquisition and analysis algorithms and clinical reevaluation are needed.