Continuous Non-invasive Hemoglobin Monitoring in Infants and Neonates Undergoing Cardiac and Abdominal Surgery

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Introduction
The recently introduced non-invasive Pulse-CO-Oximetry monitoring system (Masimo Rainbow SET Pulse COOximetry) offers the ability to continuously estimate total hemoglobin (SpHb). However, today only few data are available stressing the question whether non-invasive hemoglobin monitoring can be used for the decision making process whether to transfuse red blood cells or not. Especially in infants and neonates the ability to measure hemoglobin continuously and non-invasively would be very helpful with respect to adequate patient blood management. The purpose of the present study was to evaluate the accuracy of SpHb compared with hemoglobin values obtained by repeatedly drawn arterial blood gas analyses (HbABGA) in infants and neonates undergoing major surgery.

Methods
78 patients scheduled for major abdominal surgery (n=26) and congenital heart surgery (n=52) were enrolled in this study. Intraoperative monitoring included a central venous line, invasive measurement of blood pressure using either a femoral artery or a radial artery and a non-invasive hemoglobin sensor (Masimo Corp. Irvine CA). Hemodynamic variables included central venous pressure, mean arterial pressure, heart rate, oxygen saturation, SpHb and HbABGA using a point of care technology (POC) (GEM® PremierTM 4000). Data pairs for comparison were obtained each time the attending anesthesiologist deemed it necessary to update the instantaneous total hemoglobin with an arterial blood gas analysis.

Results
Mean age of the patients was 18±22 months, and mean body weight was 10±8kg. A total of 397 data pairs comparing SpHb with HbABGA were collected. Due to an extremely low perfusion index (PI< 0.5%) during 12 time points of data collection the Pulse CO-Oximetry technology was not able to track any SpHb values. SpHb values ranged from 3.0 to 18.1 g/dl, and HbABGA values ranged from 6.2 to 18.7 g/dl. SpHb estimation showed a significant correlation with the POC technology (r=0.57, p<0.0001). Bland Altman analysis revealed a bias of 0.61 g/dl and a precision of 2,2 g/dl yielding a percentage error of 37% (Fig. 1). SpHb overestimated Hb compared to POC-Hb in 242 from 385 data pairs (62%), and underestimated Hb in 143 from 385 data pairs (38%). In 182 data pairs out of 385 (47%) SpHb showed a deviation of more than 15%, mostly related to impaired peripheral perfusion situations, indicated by low perfusion indices (Fig. 2).

Conclusion
The presented data in this patient population of infants and neonates undergoing major cardiac and abdominal surgery suggest, that the non-invasive assessment of hemoglobin at present should be interpreted with caution and the decision whether to transfuse or not should still be based on invasive measurements of hemoglobin.