SaO_2 Dependency of Neonatal Pulse Oximetry Accuracy: A Root Mean Square Error Analysis.
Gerstmann D., Berg R., Haskell R., Brower C., Smith B. *Respir Care* 2003; 48 (11).

Objective
To apply a root mean square error analysis to pulse oximeter derived SpO2 compared to arterial SaO2 values obtained from neonatal intensive care unit (NICU) patients who require arterial access.

Methods
740 paired SpO2 and SaO2 values from 42 NICU patients were utilized in the analysis. Data were collected on 3 neonatal pulse oximeters. The root mean square statistic, Arms = [(1/n) Si Sj ([SpO2-SaO2]ij)2]1/2, was calculated across patients (i) and samples (j), then separated into 3 components: "within subject" variation (VARWS), "between subject" variation (VARBS) , and a "bias squared" (BIASSQ) term. Arms, VARWS, VARBS, and BIASSQ were analyzed in relationship to: a) patient accrual, and b) arterial saturation values.

Results
Based on patient accrual, values of Arms, VARWS, and VARBS stabilized by 20-25 patients, whereas the BIASSQ term stabilized somewhat sooner, by 15-20 patients. VARWS seemed consistent between devices, but VARBS was less so. Overall, device Arms was biased by the uneven distribution of samples across SaO2. All devices demonstrated a similar relationship between Arms and SaO2, which reached minimum values over a narrow range of SaO2 (94-97%). Above and below this range Arms increased 2 fold at 99% SaO2 and 3-6 fold at 82% SaO2. The largest contributor to the increase in Arms outside the minimum range was BIASSQ, the device measurement error. This component of Arms variation is not accounted for by VARWS or VARBS, and is characterized by the slope of the difference function, [SpO2-SaO2] vs SaO2.

Conclusion
The variance of neonatal pulse oximetry readings is dependent on the SaO2 at which the reading is taken. It is a function of the variability of taking readings on a single patient, taking readings between multiple patients, and the degree of equipment accuracy. The 95% confidence interval for readings at minimum Arms (SaO2≈95%) is approximately ±4 sat %, and for SpO2 at 85%, the 95% confidence interval is approximately ±10 sat %.