Accuracy of Pulse Oximeters during Neonatal Motion.
Liberman R., Holmes M., Taschuk R Snelling R. *Respir Care.* 1999;44(12);1499.

Background
Pulse oximetry has been used for over a decade in the NICU as an indicator of pulse rate (PR) and oxygen saturation (SpO2) of arterial blood. However, the validity of PR and SpO2 readings are often suspect during motion. Masimo SET pulse oximetry (Masimo Corp, Irvine, CA) claims to measure during motion conditions as well as low perfusion. Nellcor Puritan Bennett (Pleasanton, CA) makes a similar claim with Oxismart technology (e.g., N-295) but not with their N-200 pulse oximeters.

Methods
Sensors from a Masimo SET and a N-295 pulse oximeter were attached to opposing feet of an infant, whose feet were secured to a motion generator. The motion generator provided neonatal movement and was configured to simulate a kicking infant in frequency and amplitude. An additional pulse oximeter (N-200) was attached to the infant's right hand, which served as a stationary reference site (i.e., not exposed to the motion generator). Data (ECG heart rate, PR and SpO2) were collected every second (1 Hz) by a computerized data acquisition (DAQ) system. A blood specimen (ABG) was drawn after 30 to 120 seconds of motion. The ABG draw time was noted in the DAQ file. The sensors were switched between feet and another ABG obtained after 30 - 120 seconds of applied motion. An AVL OMNI (AVL List GmbH Medizintechnik. Graz, Austria) was used for ABG analysis of pH, PCO2, PO2, total Hb, %COHb, %MetHb, and functional %SaO2. The bias and precision of PR versus the ECG monitor heart rate and SpO2 versus functional %SaO2 were calculated.

Results
122 ABG and DAQ samples were analyzed from 14 newborns: gestation of 22 - 40 weeks and weight of 495 - 4100 gms. Ten zero outs (SpO2 display of 0 %) and one outlier > 6S were excluded from the calculations [N-295 (8), N-200 (2), and Masimo (1)]. The heart rate (via ECG monitor) ranged from 83 to 200 bpm. The ranges of ABG values were: pH of 7.20 to 7.55, PCO2 of 22.0 to 63.6 mmHg, PO2 of 44.4 to 111.6 mmHg, total Hb of 9.4 to 17.3, COHb of 0.0 to 4.2 %, MetHb of 0.8 to 2.6%, and SaO2 of 82.7 to 95.8 %.

	Oximeter PR [bias] (precision)	SpO2 [bias] (precision)
Masimo SET	-0.1 (± 3.0)	-0.9 (± 2.3)
N-295	-3.4 (± 18.0)	+5.1 (± 8.1)
N-200	+5.2 (± 20.9)	+0.3 (± 4.6)

Discussion
Most pulse oximeter manufacturers state a precision for pulse rate of ± 3 bpm and a precision for SpO2 of ± 3 % (at a bias of 0) in neonates during non-motion conditions. However, motion is common in this population. Motion adversely affects most pulse oximeters and spurious values can lead to inappropriate care. Conventional pulse oximeters, including Oxismart, performed much worse than their published accuracy specification in this study. Masimo SET pulse oximetry reflected SaO2 and ECG heart rate accurately during motion and broad use should improve care.