

## **Comparison of Three New Technology Pulse Oximeters during Recovery from Extreme Exercise in Adult Males.**

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### **Introduction**

Several manufacturers claim that technologies recently introduced (DSP, SET and Oxismart) improve performance of pulse oximetry in conditions of low perfusion and subject motion. Digital signal processing (DSP) was introduced in the BCI MicroSpan model 3304 pulse oximeter (SIMS BCI, Inc., Waukesha, WI). Masimo SET pulse oximetry (Masimo Corporation, Irvine, CA) uses unique sensor design and software algorithms. The NellcorPB (NPB) model 295 pulse oximeter (Mallinckrodt, Inc., St. Louis, MO) uses Oxismart signal processing.

### **Methods**

Five US Navy SEAL candidates were evaluated post exercise. Sensors were attached to fingers of the same hand during medical examination. The oxygen saturation (SpO<sub>2</sub>) and pulse rate (PR) data were collected by a computerized data acquisition (DAQ) system. The DAQ file for each subject was analyzed for accuracy (% time where "non-frozen" SpO<sub>2</sub> post-processed SpO<sub>2</sub>), zero-outs (ZO, number of times the SpO<sub>2</sub> display was zero), and pop-outs (PO, number of times the SpO<sub>2</sub> was >5 digits from other oximeters. When a pulse oximeter displayed SpO<sub>2</sub> values >5 digits from other oximeters, raw waveform analysis was done. This post- processing technique calculated the correct SpO<sub>2</sub> from the detected red and infrared light signals (Comp. Bio. Med. 26:143-159, 1996). False values were tabulated and epochs of "frozen" data captured (Oxismart motion artifact or pulse search prompts).

### **Results**

Total monitoring time was 41 minutes (8.2±4.5 minutes/subject). Subjects needed SpO<sub>2</sub> monitored for pneumonia (2), pulmonary edema (1), hypothermia (1) and heat exhaustion with hypoglycemia (1); 3 were shivering or shaking. In 3 subjects, the fingers were cold, pale and appeared poorly perfused.

### **Conclusions**

This subject population challenged some of these new pulse oximeter technologies. BCI DSP was inaccurate 11% of the time and NPB Oxismart 33% versus 0% for Masimo SET. Poor performance for Oxismart was due in part to frozen data (153 epochs for a mean of 29% of monitoring time). However, the frequency and duration of zero out and pop out SpO<sub>2</sub> values was greatest for the BCI DSP. Our study of 3 units found the Masimo SET technology provided the most accurate data in subjects with low perfusion and involuntary motion.