

Comparison of Three New Technology Pulse Oximeters During Recovery from Extreme Exercise in Adult Males

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Introduction

Hypothermia causes peripheral hypoperfusion, which, if sustained, produces localized hypoxemia. Sustained low perfusion increases the arterial-venous O₂ difference so that with motion the detection of pulsating non-arterial blood produces pulse peaks that do not correspond with arterial saturation and are entered into the display of SpO₂. The lower and more sustained the perfusion, the worse the oxygen delivery. The result is a low venous oxygen saturation, which during motion produces very low SpO₂ values (well outside the stated accuracy claims of $\pm 2\%$). Several pulse oximetry manufacturers (Masimo, Nellcor and SIMS BCI) have made claims that their new technologies (SET, Oxismart and DSP) are resistant to motion and low perfusion conditions.

Methods

Five US Navy SEAL candidates were evaluated post cold water exercise with 3 new technology pulse oximeters: the BCI Microspan Model 3304 with DSP, Ohmeda 2000 with Masimo SET and Nellcor N-295 with Oxismart. Pulse oximetry was used in the routine physical assessment as a spot check of cardio-pulmonary status. The pulse oximeter sensors were randomly placed on three fingers of the same hand (index, middle and ring) and then covered to prevent optical cross talk. Data was collected simultaneously into a computer and post-processing analysis performed for accuracy (% time where device was within 5% of reference and not "frozen"), zero-outs (frequency and duration of time where the display was zero), and pop-outs (frequency and duration of time where the displayed value was outside 5% of reference but not zero).

Results

Total monitoring time was 41 minutes (8.2 ± 4.5 minutes/subject) The subjects challenged these new pulse oximeter technologies in that the majority of subjects were shivering or shaking having monitoring sites that appeared cold, pale and poorly perfused. Two subjects were found to have pneumonia, one had pulmonary edema and these diagnoses were aided by use of the pulse oximetry. The BCI DSP was inaccurate 11% of the time and Nellcor 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 SpO₂ values was greatest for BCI DSP.

Category	 Masimo SET	BCI DSP	Nellcor Oxismart
Accuracy (%)	100	89	67
Zero Outs (total time)	0 (0)	4 (1.4 min)	2 (0.02 min)
Pop Outs (total time)	0 (0)	3 (4.3 min)	2 (1.5 min)
Frozen Data (% total time)	0	0	29

Authors' Discussion and Conclusions

Spot checks with pulse oximetry for the assessment of cardio-pulmonary status can be aided by use of pulse oximetry. Some pulse oximeters miss large portions of real data or freeze on old saturation values, which can limit the use of their technology as a screening tool, e.g., Oxismart missed one-third. **Masimo SET pulse oximetry provided accurate, real-time data during the entire assessment in spite of profound low perfusion and involuntary motion.**