

Reliable Pulse Oximetry During Exercise Testing.

Harrington S., Henderson D., Burton G.G. *Respir Care*. 1999;44(10):1226.

Background

Motion artifact (imposed and innate) and compromised monitoring site perfusion have been thought to limit the use of conventional pulse oximetry during exercise testing (AARC Clinical Practice Guideline 8/92). The Masimo SET pulse oximeter (Masimo Corp, Irvine, CA) claims to measure SpO₂ and pulse rate (PR) during motion and low perfusion conditions but its accuracy during stress testing has not yet been reported.

Methods

Adhesive sensors from Masimo SET and Nellcor N-200 (NellcorPB, Pleasanton, CA) pulse oximeters were attached to different fingers of the same hand on 5 adult volunteers with known lung disease. Each sensor was shielded to prevent optical cross-talk between the photodetectors. The subjects were exercised on a treadmill ergometer for efficiency testing of various oxygen conservation devices. The magnitude of exercise (duration and speed) was customized for each subject based upon the modified Borg dyspnea scale (Thorax 48:33-38, 1993) established during prior testing. Data (ECG heart rate, PR and SpO₂) were collected by a computerized data acquisition (DAQ) system. The DAQ file for each test period was analyzed after the study for data discrepancies. When either pulse oximeter displayed SpO₂ values > 5% from the other, raw waveform analysis was performed to calculate the SpO₂. This post-processing technique uses both time- and frequency-domain information to calculate the correct SpO₂ from the detected red and infrared light signals (Comp. Bio. Med. 26:143-159, 1996). Also compared for differences was the pulse oximeter's specification for PR and the ECG monitor heart rate ($\pm$ 3 bpm for both devices). The frequency and duration of spurious values were tabulated. Data was statistically analyzed using the Wilcoxon Rank Sum Test and significance was assumed if $p < 0.05$.

Results

The 5 subjects were 62 ± 10 years of age and all had oxygen dependent pulmonary disease. They performed 134 minutes of total treadmill ergometry during 13 separate tests (mean duration of 10.2 ± 1.3 minutes). There were 22 zero outs (SpO₂ and PR displays of zeros) and all were excluded from the calculations so as to not unduly and artificially skew the results (i.e., we biased in favor of Nellcor). The ECG heart rate ranged from 83-131 bpm.

Category	Masimo SET	Nellcor N-200	Significance
Accuracy (minutes)	129/133	101/133	Yes ($p < 0.01$)
Zero Outs	1	21	Yes ($p < 0.001$)
Range of SpO ₂ (%)	87-98	73-97	Yes ($p = 0.02$)
Range of PR (bpm)	80-144	40-210	Yes ($p < 0.005$)

Conclusions

Use of conventional pulse oximetry during exercise testing is problematic. Motion and monitoring site hypoperfusion adversely affects conventional pulse oximetry performance. 25% of the time data from the N-200 pulse oximeter was erroneous. Our findings demonstrate that the Masimo SET pulse oximeter accurately reflects SaO₂ and ECG heart rate during exercise testing of adults with lung disease. Reliable pulse oximetry during stress testing can be achieved with Masimo SET.