38 The Effect of Motion on the Accuracy of Six "Motion-Resistant" Pulse Oximeters

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Introduction

In previous studies, this researcher compared the performance of pulse oximeters during mechanically controlled motion and hypoxemia. In this study, using the same test protocol, he compared all major brands of commercially available motion resistant pulse oximeters during reduced perfusion and mechanically controlled motion (both constant and random) on volunteers breathing room air and hypoxic gas mixtures.

Methods

Thirty (30) healthy volunteers participated in the study. To simulate low perfusion, the room was cooled until the majority of the subjects' perfusion was less than normal (< 0.8% arterial pulse strength compared to DC-non pulsating signal). The author found other modes of reducing perfusion, such as occlusion of the arterial blood, to be a less viable model.

Each volunteer was instrumented with pulse oximeter sensors; three on the non-moving "control" hand, and three on the moving "test" hand. Because the pinky and the thumb do not experience the same motion or perfusion as the other fingers they were not used. In all trials, a Masimo SET pulse oximeter was compared with two other pulse oximeters. A computer-controlled motorized motion device produced repeatable tapping and rubbing motions from one subject to the next. Measurements of SpO_2 were made while the subjects breathed room air as well as, during quick desaturations to approximately 75% to 80% and resaturation back to baseline. SpO_2 values during motion on the test hand were compared with values from the control hand. The motions were continuous through the desaturation and resaturation in order to make the test challenging and not give time for the monitors to reacquire on non-motion signal. During room air the motion was continuous for 2 minutes. The motions were both random/erratic using a pseudo random motion generator and periodic at 3 Hz (180BPM). Test and control SpO_2 values were compared in terms of sensitivity and specificity. Sensitivity measured a pulse oximeter's ability to detect true desaturation, and specificity measured the pulse oximeter's likelihood of not generating false alarms during motion. A SpO_2 of 90% was chosen as the low alarm threshold. A SpO_2 performance index (SpO_2 PI) and drop out rate were calculated for each pulse oximeter. The SpO_2 PI measured the percentage of total time the displayed SpO_2 was within 7% of the control. The drop out % measured the total time the SpO_2 displayed was either zero or dashes.

Oximeter	SpO_2 Sensitivity	SpO_2 Specificity	SpO_2 Performance Index	Drop Out
Masimo SET	99%	97%	93%	0.0%
Philips/HP Viridia 24C Rev B.0	78%	90%	84%	1.6%
Philips/HP CMS Rev B.0	70%	83%	80%	3.7%
Nellcor N-395	70%	73%	73%	4.0%
Datex-Ohemda 3900	60%	52%	68%	1.0%
Novametrix MARS	40%	42%	58%	2.4%
Nellcor N-295	39%	53%	55%	7.8%

Authors' Discussion and Conclusion

"We used a proven challenging motion and low perfusion protocol which has produced consistent results in several studies to test all commercially available products claiming to work under motion conditions. In our experiments, the Masimo SET pulse oximeter performs significantly better during motion and low perfusion than the other devices. **The Masimo SET not only had no drop outs, but also was the only product with high sensitivity and specificity under challenging motion and low perfusion conditions.** Masimo SET pulse oximetry represents a significant step forward by providing clinicians with more accurate data with which to treat their patients, particularly in clinical settings in which patient motion is likely."

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