

Artifact Resistance of Newest Generation of Pulse Oximeters in Volunteers Undergoing Hypoxemia.

Gehring H., Hornberger C., Matz H., Konecny E., Schmucker P. *Anesthesiology* 2000; 93(3A): A-584

Background

When it is necessary to abandon pulse oximeter monitoring, temporarily or permanently, the most common reasons are restricted peripheral perfusion and movement artifacts. The objective of this study therefore was to test the effects of motion artifact and/or low perfusion on the performance of a new generation of pulse oximeters in healthy adult volunteers undergoing hypoxemia. Special attention was directed to SpO₂ and pulse rate accuracy, and to the handling of warning messages.

Methods

During episodes of induced hypoxemia in ten healthy volunteers a continuous recording was made of SpO₂ and pulse rate and of signal-quality warnings. Five different pulse oximeters from four different manufacturers were tested: Datex-Ohmeda 3900, Agilent Technologies (formerly Hewlett-Packard) CMS monitor software Rev. B.0, Nellcor/Mallinckrodt N-3000 and N-395, and a Schiller OX-1 (the European version of the US Masimo/Ivy 2000) with Masimo SET™ technology. Volunteer test subjects participated after written informed consent and approval by the Ethics Committee. Motion artifacts were generated using exogenous motion generated by a standardized and repeatable motion machine as well as by having the test subject perform voluntary tapping and scratching motions. Perfusion to the finger was reduced by use of an inflatable balloon impinging on the brachial artery. The pulse oximeters' readings were compared to control pulse oximeters (Nellcor N-3000) on an unperturbed reference hand. Pulse rates from the test oximeters were compared to an ECG-derived heart rate. Warnings that alerted the user to possible untrustworthiness of the displayed value were analyzed.

Results

Performance of the different instruments was compared over a wide range of artifact influence. The percentage of time when the SpO₂ deviation was within $\pm 3\%$ SpO₂ of reference reading was $>95\%$ for all instruments without artifact simulation.

For the most difficult situation for pulse oximeters, which was the combination of motion and reduced perfusion, the percentage of errors exceeding given limits are listed in table 1. The first two rows give the percentage of SpO₂-error larger than $\pm 3\%$ and $\pm 6\%$ respectively. In the third row the percentage of SpO₂-error $> 10\%$ is given in situations when the pulse oximeter gave no warning message. In the last row the pulse rate errors exceeding 25 bpm are listed. Table 1: Percentage of SpO₂ and pulse rate errors during the period of motion and reduced perfusion

Conclusion

Combining performance with respect to SpO₂ accuracy, pulse rate accuracy and alarm handling, the Nellcor N-395 was best, followed by the Agilent and the Masimo/Ivy-2000. The performance of the Datex-Ohmeda is lowered by poor pulse rate accuracy. The Nellcor N-3000, one of the best instruments of the previous generation, placed last in the evaluation.

	Agilent	Datex-Ohmeda	Masimo/ly	N-3000	N-395
S _p O ₂ -error >3%	50%	41%	43%	52%	38%
S _p O ₂ -error >6%	26%	21%	27%	26%	13%
S _p O ₂ -error >10% and no warning	6.5%	8.6%	14%	5.1%	2.1%
pulse error >25 bpm	8.5%	53%	1.1%	37%	5.3%