Effects of IABP and Cardiac Arrhythmia on Pulse Oximetry.

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Introduction

In order to decrease the frequency of false positive alarms in pulse oximetry new proprietary algorithms have been implemented to realize motion-resistant devices [1]. However, aside from low perfusion or motion, cardiac arrhythmia and intra-aortic balloon pumps (IAPB) [3] affect the arterial pulse waveform. Therefore the objective of this study was to determine - under clinical conditions - the reliability of pulse oximetry if arrhythmia or IABP are present [2].

Method

After institutional approval and informed consent, 42 ICU patients (ASA physical status II-IV) after cardiac surgery, 21 out of them treated with IABP postoperatively and 21 patients suffering from mostly transient cardiac arrhythmia, were simultaneously connected to three third generation pulse oximeters (placed at fingers II-IV in arbitrary sequence), each utilizing a specific signal processing method: Agilent Viridia CMS, Nellcor Symphony® N-3000 and Masimo SET. Functional saturation (SpO2) and pulse rate (PR) were recorded continuously by means of a PC, alarm events were classified immediately by an experienced anesthesiologist into technical/physiological and false/correct with the alarm limits adjusted to the patient`s current clinical state. Sensitivity and specificity were calculated as follows: Specificity=TN/(TN+FP), sensitivity=TP/(TP+FN) (TN=true negative alarm, FP=false positive alarm, TP=true positive alarm, FN=false negative alarm).

Results

In presence of IABP, alarms occurred every 3.1 minutes, in the course of cardiac arrhythmia every 4.3 minutes. With IABP Viridia CMS indicated the smallest number of false positive alarms (n=35, 7.2%) compared to Masimo SET (n=188, 38.9%) and N-3000 (n=229, 47.4%), but the highest with cardiac arrhythmia (n=96, 27.8%) (Masimo SET n=78, 22.5%; N-3000: n=43, 12.4%). Additionally, with IABP CMS accounted for 30, N-3000 for 35, and Masimo for 13 true negative events providing for superior specificity of the CMS (Tab 1). Moreover, the standard deviation of the SpO2 readings of all devices largely exceeded their specified accuracy on condition that IABP is applied. In all patients the overall dropout time during a total measuring time of 50 hrs, in which no data were available for technical reasons, was shortest with the Masimo SET (1.0% with IABP, and 1.8% with arrhythmia, respectively), considerably longer with the Virida CMS (6.7%, 5.1%) and the N-3000 (7.9%, 6.7%).

Conclusion

With respect to motion or low perfusion false alarms were detected in only 33.4% of the patients, but the majority of false positive alarms can be rated as a result of the interference of cardiac arrhythmia (47.1%) or IABP (76.2%). With IAPB the reliability of SpO2 and pulse rate determination by third generation pulse oximeters is significantly decreased, but is less compromised in patients with cardiac arrhythmia particularly when a N-3000 is used.

Reference: 1. Barker SJ et al. (2001), STA Proceedings: 2; 2. Lutter N et al. (2001) STA Proceedings: 11; 3. Mehlborn U et al. (1999), Thorac Cardiovasc Surg 47 Suppl 2:298-303.

Tab 1		IABP	Arrhythmia
CMS	sensitivity	26.8%	95.2%
	specificity	88.7%	43.6%
N-3000	sensitivity	14.6%	100.0%
	specificity	26.1%	75.0%
Masimo	sensitivity	51.9%	98.0%
	specificity	42.0%	52,4%