

## **Performance of Three Fourth-Generation Pulse Oximeters during Electro-Convulsive Therapy.**

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### **Introduction**

Implementing different sophisticated digital signal processing methods that essentially depend on cardiac-based and saturation-based filtering substantially improved pulse oximeter tolerance to motion artifact<sup>1</sup>. As these algorithms especially designed to compensate for motion artifacts may affect the pulse oximeter's responsiveness the aim of this clinical study was to determine the reliability of pulse oximetry if transient alterations of heart rate or saturation are present.

### **Method**

After institutional approval and informed consent, 43 patients (ASA physical status I-II, aged between 18 and 75 years) receiving electro-convulsive therapy under general anesthesia were included into the study. Three motion-resistant pulse oximeters were randomly placed at fingers II-IV, each utilizing a specific proprietary signal processing technology: Agilent Viridia CMS, Nellcor N-395 and Masimo SET. Functional saturation (SpO<sub>2</sub>), pulse rate (PR) and heart rate (HR) were recorded continuously using 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 clinical state prior to treatment. Sensitivity and specificity were then calculated off-line: 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**

During the procedure significant tachycardia (112 to 172 bpm) occurred in 25 patients resulting in a time lag between HR as referred to the ECG and corresponding PR changes: The monitor's response was delayed by 21.5±13.6 sec for CMS, 15.3±7.1 sec for N-395, and 8.5±5.3 sec for Masimo with these differences statistically significant (p<0.05). In 18 of these 25 patients the pulse oximeters indicated mild to moderate hypoxemia with Masimo providing for the lowest SpO<sub>2</sub> readings (CMS: 80±10%, N-395: 76±10%, Masimo: 72±15%), however, none of the differences proved statistically significant after normalizing all saturation drops over the mean decrease in saturation. In phase with the PR ascent 11 dropout events were observed with CMS, 6 with N-395 and 6 with Masimo, accounting for 1 to 5% of the time of tachycardia episodes. Subsequent to a total of 150 alarms the highest specificity could be assigned to CMS: 100% (N-395: 89%, Masimo: 92%), with respect to sensitivity the N-395 performed best (CMS: 71%, N-395: 95%, Masimo 72%).

### **Conclusion**

Although the overall performance of the pulse oximeters in terms of sensitivity and specificity during transient tachycardia is acceptable, the algorithms to process artifactual signals (2) assumingly result in delayed PR determination subsequent to tachycardia. Instrument dropout in 44% of these patients and, additionally, circulatory lag time further postpone appropriate SpO<sub>2</sub> indication especially important to concurrently hypoxemic patients.