

# The Impact of Motion and Low Perfusion on the Performance of Masimo SET Pulse Oximeter (PO) and Four other POs for Measurement of Oxygen Saturation (SpO<sub>2</sub>) and Pulse Rate (PR) in Human Volunteers

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## Introduction

Since conventional pulse oximeters often display erroneous values, clinicians often rely on correlation between the ECG heart rate and the pulse oximeter's pulse rate to validate the SpO<sub>2</sub> value. Thus pulse rate measured by pulse oximetry plays a significant role in the clinician's trust of the SpO<sub>2</sub> value given by the pulse oximeter. Many manufacturers claim improved performance during motion and low perfusion. Therefore, this group of researchers undertook this study to assess the impact of motion and low perfusion on SpO<sub>2</sub> and pulse rate performance of "motion resistant" pulse oximeters in human volunteers.

## Methods

Seven (7) healthy adults (5 females and 2 males) between 18 and 40 years of age were enrolled after obtaining informed consent. Masimo Radical v3 (Masimo I) was compared with HP Agilent Viridia 24C Rev C.0, and Novametrix MARS Model 2001-10 in one series of tests. Masimo Radical v3 (Masimo II) was compared with Nellcor N-395 v1620, and HP CMS Rev C.0 in a second series of tests on the same subjects. An Ohmeda pulse oximeter ear sensor was used as the control for hypoxemia. The room temperature was lowered to 16° to 18° C to lower peripheral perfusion of the volunteers. The left hand was the test hand while the right hand served as the control. The sensors were randomly placed on index, middle and ring fingers. The motion (performed by a motor-driven motion table) during normoxia (breathing room air) consisted of tapping at 3 Hz, tapping at 3 Hz with disconnect and reconnect of the sensors during motion, and random rubbing. The sensors were then rotated in a lateral fashion allowing for sensor placement of each PO on each of the three fingers and the motions were repeated after each sensor change. Hypoxemia was induced employing a disposable re-breathing circuit with a CO<sub>2</sub> absorber to a SpO<sub>2</sub> ≈ 75%. The motion during hypoxemia consisted of random tapping and 3 Hz tapping with disconnect and reconnect of the sensors during motion, random rubbing, and 3 Hz rubbing. Once the SpO<sub>2</sub> reached 75% as measured by ear sensor, the subjects were given 100% O<sub>2</sub> to breathe until his/her SpO<sub>2</sub> on the control monitor reached 100%. Pulse rate and SpO<sub>2</sub> data were recorded on-line for off-line analysis. % of the time when pulse rate was off by 10% (Off 10) or more and SpO<sub>2</sub> was off by 7% or more (Off 7), performance index (PI) - % of time when SpO<sub>2</sub> was within 7% of control and PR was within 10% of control, and % of time when the pulse oximeters zeroed out pulse rate and/or SpO<sub>2</sub> (Zero rate). Analysis of Variance was used for statistical analysis and p <.05 was considered statistically significant.

## Results

The results are shown in the table. ANOVA analysis showed a statistically significant difference between the performance of the pulse oximeters for both SpO<sub>2</sub> and PR.

Pulse Oximeter	Pulse Rate			SpO <sub>2</sub>		
	Off10%	PI	Zero rate	Off7%	PI	Zero rate
Masimo SET I	20%	80%	0.5%	14%	85%	0.6%
HP Viridia 24C Rev C.0	53%	47%	1.6%	34%	65%	1.6%
Novametrix MARS	72%	27%	2.1%	58%	41%	2.2%
Masimo SET II	21%	78%	0.1%	11%	89%	0.2%
N-395	40%	50%	16.7%	33%	63%	6.0%
HP CMS Rev C.0	32%	67%	0.9%	21%	78%	1.6%

## Authors' Discussion and Conclusion

"While no PO technology amongst the tested POs was able to withstand this vigorous testing schedule 100% of the time for either SpO<sub>2</sub> or PR, Masimo SET technology performed better for both SpO<sub>2</sub> as well as PR. Furthermore, all POs performed inferiorly for detection of PR in comparison to SpO<sub>2</sub> detection."