

## **The Performance of Six "Motion-Resistant" Pulse Oximeters during Motion, Hypoxemia, and Low Perfusion in Volunteers.**

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### **Introduction**

Pulse oximeters are subject to several errors caused by patient motion. We have previously compared the performance of various pulse oximeters in volunteers during controlled motions and hypoxemia.<sup>1,2</sup> In the present study, we compare SpO<sub>2</sub> accuracy and reliability in 6 recent model pulse oximeters, all of which claim to be motion resistant. For comparison with older technology, we included one earlier instrument (N-295).

### **Methods**

Thirty healthy volunteers were each instrumented with six oximeter sensors: three on the moving test hand, and three on the stationary control hand. The Masimo SET oximeter was compared with two other units on each subject. A motor-driven motion table produced repeatable finger tapping and rubbing motions. A modified anesthesia machine with circle system and mask delivered hypoxic gas mixtures with inspired oxygen fractions as low as 10%. SpO<sub>2</sub> and pulse rate were recorded continuously, both while subjects breathed room air and during rapid desaturations to SpO<sub>2</sub> = 70-75%. Values obtained during motion were compared with simultaneous values from the control hand. Test and control values were compared by means of signal dropout rate, sensitivity and specificity for hypoxemia detection, and Performance Index (PI). The latter is the percentage of time during which the oximeter provides SpO<sub>2</sub> readings that are within 7% of control values. For sensitivity and specificity, the hypoxemia alarm threshold was set at SpO<sub>2</sub> = 90%. The room temperature was held at 15-18 deg-C during the entire study, to reduce peripheral perfusion and better simulate actual patients. Subjects' measured finger skin temperatures ranged from 20 to 26 deg-C.

### **Results**

The results are summarized in Table 1, which shows the performance index, dropout rate, sensitivity and specificity for hypoxemia detection. The oximeters in the table are listed in descending order of performance index.

### **Discussion**

The Masimo pulse oximeter had a PI value of 93% during motion, with a sensitivity of 99% and specificity of 97%. The next best performer was the Agilent Viridia 24C, with values of 84%, 78%, and 90% respectively. The Nellcor N-295 was included to show a comparison with older generation technology, and its PI value was much lower at 55%. The Masimo SET pulse oximeter showed the best performance of all units during motion, in terms of both accuracy and reliability. A key difference between this and other volunteer studies is the fact that we maintained skin temperatures below normal to reduce perfusion and better represent patients in critical care settings.

<b>Pulse Oximeter</b>	<b>Perform. Index%</b>	<b>Dropout%</b>	<b>Sensitivity%</b>	<b>Specificity%</b>
Masimo SET	93	0.0	99	97
Agilent Viridia 24/C	84	1.6	78	90
Agilent CMS-B	80	3.7	70	83
Nellcor N-395	73	4.0	70	73
Datex-Ohmeda 3900	68	1.0	60	52
Novametrix MARS	58	2.4	40	42
Nellcor N-295	55	7.8	39	53