Comparative Analysis of Signal Accuracy of Three SpO₂ Monitors During Motion and Non-Motion Conditions

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Background
- Pulse oximetry (SpO₂) is the standard of care for assessing oxygen saturation in the acute care setting.
- Motion artifact degrades pulse oximeter performance and represents a clinical challenge.
- Manufacturers have developed pulse oximetry technologies to minimize the impact of motion on sensor performance.

Objectives
- A comparative study was conducted to evaluate SpO₂ accuracy of three currently available devices: GE CARESCAPE TS10000, Masimo Rad-7, and Medtronic Nellcor PM1000N, during motion and non-motion conditions.

Methods
- After University of California San Francisco IRB approval, a healthy adult (33 years) volunteer non-smokers with normal high levels were recruited for this prospective, open-labeled study.
- Testing was conducted using a minimum of 10 subjects, including 12 subjects with a history of sleep disorders.
- Skin pigmentation was categorized by Fitzpatrick scale.
- All 3 pulse oximeters were placed on both hands: one hand was motion and one hand was non-motion.
- A randomized, counter-balanced approach for SpO₂, finger placement to control for order bias.
- The non-motion hand had an arm catheter to avoid sampling reference oximetry analyzers (SpO₂) measurements.
- SpO₂ readings from the 3 devices on the motion hand were compared to SpO₂ readings from the corresponding devices on the non-motion hand.
- Data were collected using three motion conditions (standing, sitting, and supine) and under 3 oxygenation conditions (room air, oxygen desaturation to <90%, and re-saturation phase).
- Descriptive data for comparison included the Accuracy Root Mean Square (ARMS) bias, and absolute delta (AD).

Results

Fig. 1

Discussion and Conclusions
- The study sample (N=14) included 9 male and 5 female subjects, with a mean age of 38.1 years (SD=5.3) and a range of 24-43.
- Skin tones varied by the Fitzpatrick scale as Type II (N=1), Type III (N=6), Type IV (N=5), and Type V (N=1), Ethnicity was Asian (N=5), Caucasian (N=5), Hispanic (N=2), Black (N=1), and Multiracial (N=1).
- In motion conditions, mean ARMS (Fig. 1) for the 3 devices across all saturation levels were: 1.15 (GE), 1.58 (Maximo) and 2.51 (Nellcor), with overall mean bias (Fig. 2) of 0.41 (Maximo), 0.44 (GE), and 0.59 (Nellcor).
- During motion conditions, mean ARMS (Fig. 1) were 1.81 (GE), 3.43 (Maximo), and 4.52 (Nellcor), with overall mean bias (Fig. 4) of -0.92 (Maximo), 0.06 (GE), and -0.13 (Nellcor).
- The AOS for all saturation levels was 4.7% (GE), 7.9% (Maximo), and 16.3% (Nellcor). AOS for non-motion was: 0.8% (GE), 3.0% (Maximo), and 5.8% (Nellcor).
- Under 3 simulated conditions for both motion and oxygenation, the Nellcor, GE, and Maximo pulse oximetry technologies demonstrated comparable performance, with no single device having the best measurements under all conditions.
- The clinical relevance of these results requires further study during actual clinical use.

Directions for further study
- Evaluation of the technologies during clinical care under various measurement conditions.
- Subgroup analysis based on skin pigmentation levels.
- Analysis for statistically significant differences between technologies.

References

DISCLOSURES
Affiliations of all authors are associated with GE Healthcare.
All authors have nothing to disclose related to GE Healthcare.