Is There a Difference in the Recovery Time for the Accurate Display of Oxygen Saturation (SpO2) and Pulse Rate (PR) after Motion Induced Failure of Pulse Oximeters (PO) during Low Perfusion and Normoxemia or Hypoxemia in Human Volunteers?

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Introduction

Monitoring Pulse Oximetry has become standard of care in OR and PACU. Patient movement is very common in the PACU and in the OR especially at the critical time of extubation. Unfortunately, conventional POs may not function well during motion. How long the PO takes to recover and display accurate SpO2 and PR after motion induced failure may be of paramount importance. To the best of our knowledge, recovery time of SpO2 and PR after motion have not been reported. We undertook this study to compare the recovery time for SpO2 and PR for five major brands with new PO technologies.

Methods

Seven ASA I adult volunteers (5-females & 2-males) between 18 & 40 years of age were enrolled after obtaining informed consent. Masimo Radical v3 (Masimo I) was compared with HP Agilent Viridia 24C Rev B, and Novametrix MARS Model v2001-10. Masimo Radical v3 (Masimo II) was compared with Nellcor N-395 v1620, and HP CMS Rev B. An Ohmeda PO with ear sensor was used as the control for titration of hypoxemia. The room temperature was lowered to 16 to 18 degree C to reduce 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, & 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. The study was repeated with two other POs along with Masimo which was used in both sets of experiments. Hypoxemia was induced employing a disposable re-breathing circuit with a CO2 absorber to a SpO2 of around 75%. The motion during hypoxemia consisted of random tapping and 3 Hz tapping with disconnect and reconnect of the sensors during motions, random rubbing and 3 Hz rubbing. Once the SpO2 reached 75% as measured by ear sensor, the subjects were given 100% O2 to breathe until the SpO2 on the ear PO monitor reached 100%. SpO2 & PR data were recorded by a computer for off-line analysis. Recovery time (RT), (defined as the time required for the POs to recover for SpO2 and PR to the control value after the end of motion) of SpO2 and PR were calculated for all POs. Furthermore, failure rates (FR) (defined as the % of time the POs displayed values which were off by 7% of the control value for SpO2 and off by 10% of the control value for PR) were also calculated. Analysis of Variance (ANOVA) was used for statistical analysis & $P<.05$ was considered statistically significant.

Results

There were a total of 91 motion tests (63 during normoxemia and 28 during hypoxemia) when POs could fail. The table shows our results. * ANOVA showed a statistically significant difference between the performance of the POs for both SpO2 and PR. # ANOVA showed a statistically significant difference in the RT of PR within the subjects as well.

	SpO2*			PR*£		
PO	Mean RT in Seconds(range)	No. of times Fail/Total	FR	Mean RT in Seconds (range)	No. of times Fail/Total	FR
Masimo I	21.3 (10-50)	12/91	13%	14.4 (3-35)	24/91	26%
Novametrix MARS	22.2 (5-55)	67/91	74%	23.1 (4-63)	73/91	80%
HP Viridia 24C	31.1 (10-85)	42/91	46%	45.5 (10-192)	65/91	71%
Masimo II	17.8 (10-40)	10/91	11%	13.6 (1-39)	27/91	30%
HP CMS Rev B	40.5 (11-97)	21/91	23%	37.8 (5-103)	35/91	38%
Nellcor N-395	19.9 (10-141	36/91	40%	38.2 (7-155)	50/91	55%

Conclusion

Amongst the POs studied it appears that Masimo Radical may serve better for monitoring as it has the shortest RT and lowest FR for both SpO2 as well as PR.