

Improving Detection of Oxygen Desaturation Events with Reflectance Oximetry

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Introduction

The identification of subtle upper airway obstructions can be improved with more accurate pulse oximetry. The lapse in time for detection of respiratory events using pulse oximetry can be reduced with the selection of the sensor site (1) and methods used to smooth the data (2). This investigation compared the Apnea Risk Evaluation System device (ARES), with forehead reflectance oximetry attached to the patient without wires, to the Nonin OEM oximeter (Nonin), to confirm the accuracy of ARES reflectance oximetry across individuals including a broad spectrum of skin-pigmentation (3).

Methods:

Eighteen healthy adult volunteers (13 males, 5 females), with six darkly pigmented individuals, participated in multiple trials of 20-second breath-holds at residual volume while lying supine. Nonin-800R reflectance-sensors were placed on the foreheads over the super-orbital arteries. During the first trial, two breath-holds were conducted with the reflectance-sensors inputted to the ARES and Nonin. The sensor inputs were reversed for the second trial. In the third trial, a transmittance sensor attached to the finger was inputted to the Nonin. Outputs were acquired simultaneously from both systems.

A total of 32 finger-vs-forehead and 64 forehead-vs-forehead breath-holds were analyzed off-line to compute the SpO₂ at baseline (average 5-secs prior to breath-hold) and nadir, and the nadir latency. Nonin variables were derived using their proprietary averaging procedure. The ARES utilized median filtering of the red and infrared signals and a five-beat moving average.

Results:

For each breath hold SpO₂ recording, we extracted baseline saturation (BS) defined as the 5 second average before the beginning of the breath hold, minimal desaturation (D) due to the breath hold and desaturation latency (TD). Comparison of the finger and forehead based measurements (RM ANOVA) showed that the forehead measurements produced significantly faster response to breath holding (29.1 ± 1.3 s vs. 36.1 ± 1.4 s, mean \pm SE, $p < 0.001$, Figure 1). When both devices were applied to the forehead, the BS, D, and TD were significantly lower (RM ANOVA: $p=0.001$, $p=0.001$, $p=0.012$) in Ares compared to Nonin, but the effects of the breath holds were consistent for both devices (no significant interactions) (Figure 2).

Conclusions:

Our results demonstrate that forehead reflectance oximetry permits faster identification of the desaturation events resulting from prolonged breath holds. The results obtained with the Ares oximeter and the Nonin OEM device showed comparable reliability and were not affected by the skin pigmentation. One of the limitations of the reflectance oximetry is sensitivity to sensor pressure, but our findings show that these effects are similar in darkly and lightly pigmented subjects.

References:

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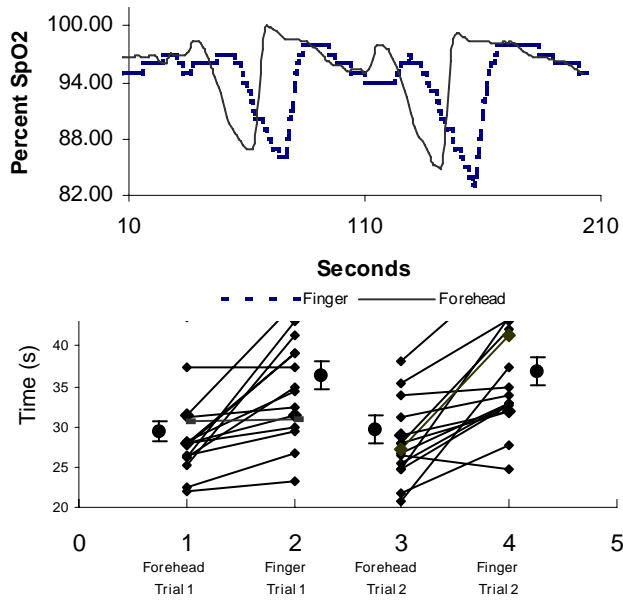


Fig. 1. a) Time delay for finger vs. ARES forehead. b) Latency from start Breath-hold to nadir for ARES vs. Nonin Averaged finger.

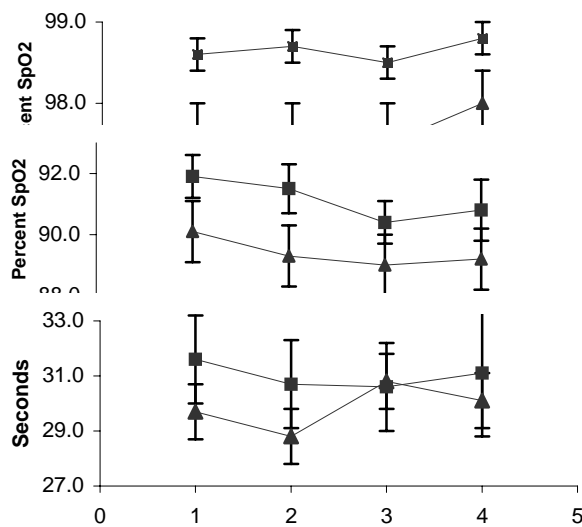


Fig. 2. SpO2 from Ares ▲ vs. Nonin ■ during 4 breathholds at a) Baseline and b) Nadir, and c) latency to baseline (secs).