Comparison of Motion Artifact Response in Three Mobile Pulse Oximeters

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Introduction

Low cost smart phone based medical devices, e.g. mobile pulse oximeter, hold great promise as diagnostic tools in low and middle income countries [1]. The artifact rejection capability of mobile oximeters is a key aspect of their performance, as their main users are likely inexperienced healthcare workers unfamiliar with plethysmography. We investigate the motion response of three models, the Nonin Xpod, the Masimo OEM inline module, and an Audio Phone Oximeter prototype [2], all interfaced to Apple iPod Touch devices.

Method

With research ethics board approval and written informed consent, 14 subjects were recruited and fitted with pairs of the three pulse oximeter models (6 devices in total , one set on each hand. The subjects were placed inside a hypoxia chamber where the inspired oxygen was gradually decreased, and asked to perform a standardized motion protocol with the dominant hand; the non-dominant hand remaining immobile. The oxygen saturation of the subjects typically varied between 100% and 75% during the hypoxic exposure. Data from all six mobile oximeters was collected and synchronized against a common time server. The motion intervals were extracted, resulting in 133,117 motion/non-motion paired readings sampled at 1 Hz.

Results

The paired readings were binned into three oxygen saturation ranges based on the non-motion values: 100-93%, 92-85% and <85%. Each bin was analyzed for motion-induced bias (Fig.1 and percentage of valid readings during motion (Fig.2, corrected for spurious fallout in the non-motion measurements. All devices exhibited a positive change in motion bias at lower saturations. The change was about 3% for Masimo and Nonin, and 12% for the Audio oximeter. The Masimo device had the biggest percentage of valid measurements during motion, about 85%-87%, while the Nonin and Audio oximeters were comparable at 60- 75%.

Conclusion

The motion response during 37 cumulative hours of mobile oximeter readings was analyzed. Compared to the Audio oximeter, both Nonin and Masimo had relatively small motion-induced bias because of advanced motion rejection algorithms. The difference is more evident at lower oxygen saturations. More work is needed to improve artifact rejection in the Audio oximeter by identifying the types of motion that have greatest impact on performance and developing algorithms to filter the true signal from the motion artifact.

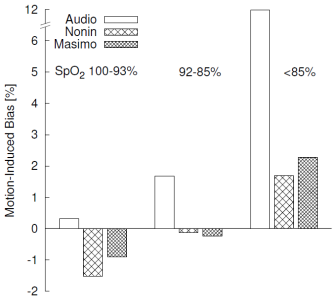

Fig. 1: Motion-induced bias

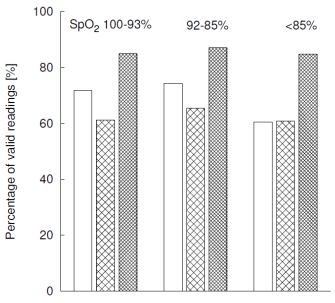

Fig. 2: Valid readings during motion

[1] The United Nations Foundation, and Vodafone Partnership. mHealth for Development: The Opportunity of Mobile Technology for Healthcare in the Developing World. 2009.
[2] Petersen, C.L.; Gan, H.; MacInnis, M.J.; Dumont, G.A.; Ansermino, J.M. Ultra-Low-Cost Clinical Pulse Oximetry. Conf Proc IEEE Eng Med Biol Soc.;2013:2874-7