Systematic Evaluation of Mobile Phone Pulse Oximetry Performance

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Background

Recent efforts to reduce hardware expenses and thereby increase global availability of pulse oximetry have led to the emergence of mobile phone based devices [1]. These new oximeters rely on consumer electronics to deliver clinical information. Systematic verification of their performance is needed; in particular with respect to low peripheral perfusion and low optical transmittance (dark skin pigmentation).

Methods

An automated testing system consisting of a Fluke ProSim 8 simulator, a desktop PC, and a third generation iPhone connected to the oximeter under test, was developed (see Fig 1). This setup allows perfusion and transmittance to be mapped automatically. We investigated a window of 0.06-8ppm transmission and 0.06-8% perfusion. For each pair of transmission and perfusion settings the corresponding readings from the oximeter were recorded. The resulting data set was rendered in a 2D visual representation, using a graded color scale corresponding to the maximum of oxygen saturation bias and standard deviation; with 0% being green and >=4% being red. This color coding reflects the ISO standard requirements for pulse oximetry [2].

Results

Three mobile phone based oximeters were evaluated: The commercially available Masimo iSpO2, the Nonin Xpod module with a custom iPhone docking connector cable, and the audio-based Phone Oximeter [3]. The resulting two-dimensional visualization of performance is shown in Fig. 2. Of the three oximeters, the Masimo iSpO2 exhibited the best dynamic range, giving valid readings down to a transmission of 0.06 ppm and a perfusion of 1 %. The Nonin Xpod showed a similar performance at low transmission, but stopped providing readings at a perfusion index below 2%. The audio oximeter had performance similar to the other two at low perfusion, but performed worse at ultra-low transmissions (<0.5ppm).

Conclusion

We have developed a new systematic test system for the evaluation of mobile phone oximeters and applied it to three different oximeter models. The results are encouraging, showing good performance in difficult clinical settings, with room for improvement at low transmission for the audio oximeter. The visual representation of the data offers an intuitive way to compare the performance of devices, and can be used to extensively verify emerging low cost phone based pulse oximeter technology.

[1] Karlen W et al. Proc. of International Conference on Health Informatics, Italy, 2011.p 433. [2] ISO 80601-2-61,Switzerland, 2011. [3] Petersen et al. Submitted to EMBC, Japan 2013.