

THE PHONE OXIMETER FOR MOBILE SPOT-CHECK

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Introduction: The Phone Oximeter is an inexpensive and portable pulse oximeter that uses a finger sensor connected to a mobile phone. This innovative device is targeted at users in developing countries with little or no availability of pulse oximetry equipment. The Phone Oximeter was initially developed by the Electrical and Computer Engineering in Medicine (ECEM) group for continuous monitoring of oxygen saturation (SpO₂) in the operating room (OR). A low SpO₂ is also a good predictor of disease severity and treatment response in a wide range of diseases such as pneumonia in children. We aim to make SpO₂ more widely usable outside the OR through quick spot-checks of SpO₂ in combination with clinical predictive models of disease states. For this, we have started by designing a mobile phone research application (PhoneOxR) to record and store accurate spot-checks of a patient's SpO₂ using the Phone Oximeter.

Methods: To develop the PhoneOxR (Figure 1), we used an iterative process of design and informal testing. PhoneOxR is comprised of:

a) The display and recording of the i) plethysmogram and ii) heart rate (HR) and SpO₂ trends.

b) A Signal Quality Index (SQI) algorithm computes the quality of the incoming measurements as a percentage (where 100 is a perfect SQI). The SQI is reduced below 100 by the presence of warning flags from the sensor's module, low plethysmogram amplitude (low perfusion) and high trend variability. Algorithm thresholds can be adjusted within the application. The SQI value is mapped to a colour: red (0), orange (0-89), or green (90-100), which is displayed as the current colour of the graph background. Changes in data quality result in prominent colour changes.

c) A horizontal progress bar shows the SQI colour over time. The recording length can be set and the recording is complete once the bar fills. The percent of the recording that was good quality, as well as the median HR and SpO₂ trend values calculated from only green (SQI > 90) sections of the recording are displayed at the end of the recording.

d) A survey component for the entry of patient details such as demographics, which are stored with all the patient's SpO₂ recordings. In the future this information can be combined to produce a predictive score of how likely the patient is to have a given disease.

Results: The PhoneOxR application provides a means of quickly obtaining a spot check recording of a patient's SpO₂ along with an indication of the quality of the recording. The final percent of data quality and colours of the progress bar may prompt the user to redo the recording, promoting the collection of good data. The PhoneOxR application is currently in use in Uganda for a clinical study on childhood sepsis.

Conclusions: The PhoneOxR is a simple application for quick and high quality spot-check recordings of SpO₂ and HR for research purposes. In the future, its utility will be greatly expanded by the use of the phone's camera and GPS to more accurately keep track of patients, and the storage of data to a secure server, which will synchronize data between multiple mobile devices in the field.

References

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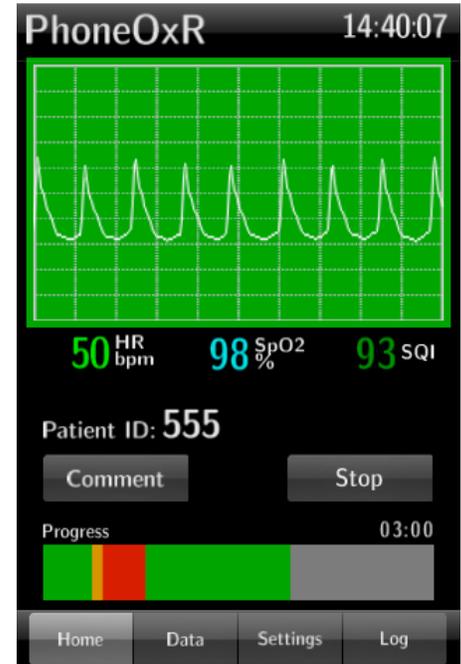


Figure 1: The PhoneOxR application's 'Home' tab displaying (a) the plethysmogram with trend values and (b) SQI below, and (c) a recording progress bar indicating SQI over time.