

Abstract ASA 2010 San Diego

Capillary Refill Time Assessment Using a Mobile Phone Application (*iRefill*)

W. Karlen, Ph.D.¹, C. Petersen, Ph.D.², A. Pickard, F.R.C.A.², G. Dumont, Ph.D.¹ and J. M. Ansermino, F.R.C.P.C.²

¹Electrical and Computer Engineering, University of British Columbia and

²Anesthesiology, Pharmacology & Therapeutics, University of British Columbia, Vancouver, BC, Canada.

Introduction

Identifying capillary refill time (CRT) is an integral part of the clinical assessment of circulatory status¹ and identification of dehydration in children². However, visual inspection of the finger to assess CRT has low inter-observer reliability^{3,4}, largely due to human limitations in estimating short time intervals. To improve precision, we have developed a mobile phone software application (*iRefill*) that automatically assesses CRT using a photo-plethysmogram (PPG) sensor. Commonly used to measure blood oxygen saturation and heart rate, this sensor can be adapted to replace the human eye to objectively measure CRT.

Materials & Methods

Prototype Development: The PPG device consisted of a PureLight small soft sensor connected to an Xpod OEM module (Nonin, Plymouth, USA). The module was connected to an iPod Touch (Apple, Cupertino, USA) that displayed the PPG waveform and recorded the data stream. The PPG was recorded with a 16bit resolution at a sampling rate of 75 Hz to an ASCII file.

The prototype: an iPod Touch is connected to the Nonin Xpod OEM sensor.

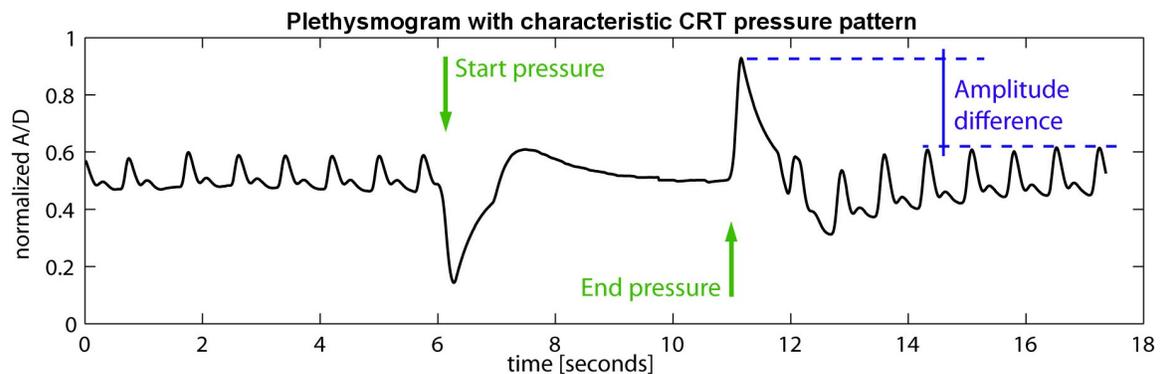


Prototype Evaluation: Twelve children between 1 and 5 years who were to undergo general anesthesia were recruited following ethical board review and written parental informed consent. While under anesthesia, the PPG sensor was placed on their right index finger. Pressure was applied to it for 5s using an infant blood pressure cuff inflated to 20mmHg above the patient's systolic blood pressure. This procedure was repeated three times on each patient.

Results & Discussion

Prototype Development: We based *iRefill* on an OpenGL for embedded systems user interface to maximize portability to mobile platforms; it currently compiles on iPhone OS, Windows, MAC OS X, and Linux. Operating with 8bit and 16bit Nonin devices, *iRefill* automatically detects the correct protocol upon connection. It is also fault tolerant, allowing the sensor to be inserted and removed during operation. The prototype can power the sensor for up to five hours (600 CRT measurements) while continuously recording and displaying data. We are investigating the integration of wireless Bluetooth-based communication into *iRefill*.

Prototype Evaluation: The PPG consistently showed a characteristic pattern across 36 normal CRT measurements. The significantly higher spike amplitude generated by the pressure release compared with the regular PPG pulse amplitude (mean difference 22% SD 10%) suggests that it is possible to automatically detect the time that pressure on the sensor has been released.



References

1. *PALS Provider Manual* Hazinski, H., Zaritsky, A., Nadkarni, V. (AHA, 2002).
2. Mackenzie, A., Barnes, G., Shann, F., *Lancet*. 2, 605-7 (1989)
3. Otieno, H. et al., *Arch Dis Child*. 89, 977-979 (2004)
4. Klupp, N., Keenan, A., *The Foot*. 17, 15-20 (2007)

Funding: University of British Columbia Martha Piper Research Fund

Summary: Prototype development and evaluation of *iRefill* for assessing capillary refill time with an iPod Touch.