Tracking Blood Pressure Changes in Anesthetized Patients: the Optical Blood Pressure Monitoring (oBPM) Technology

J. Solà, Y. Ghamri, M. Proença, F. Braun, A. Lemkaddem,
N. Pierrel, C. Verjus, M. Bertschi and P. Schoettker

***Abstract*— Routine monitoring of blood pressure during general anesthesia relies on intermittent measurements with a non-invasive brachial cuff inflated every two to five minutes. While all these patients are equipped by a fingertip pulse oximeter, the acquired optical signals currently only provide SpO2 estimates. Our running clinical trial (NCT02651558) presents the first-ever demonstration that the optical signals acquired by a fingertip pulse oximeter can also be exploited to continuously detect blood pressure changes. Results from the first 8 enrolled patients show that the Optical Blood Pressure Monitoring (oBPM) algorithms can detect rapid blood pressure changes occurring during anesthesia with 94% of accuracy. The proposed solution is expected to allow major improvements in the safety of anesthetized patient's, allowing early detection of hemodynamic changes occurring in between two routine blood pressure measurements performed with brachial cuffs.**

I. Materials and Methods

Data from a running clinical trial (NCT02651558) was analyzed [1]. The dataset included continuous optical signals from a commercial fingertip pulse oximeter (PPG), and continuous blood pressure measurements from an arterial catheter inserted at the radial artery from eight patients (Fig. 1). The goal of the analysis was to demonstrate the performance of the oBPM algorithms [2] in detecting BP changes induced by vasoactive anesthetic agents, compared to naïve predictions. Naïve predictions included BP estimates derived from HR changes (PPG-HR), and BP estimates derived from changes in PPG signal amplitude (PPG-AMP).

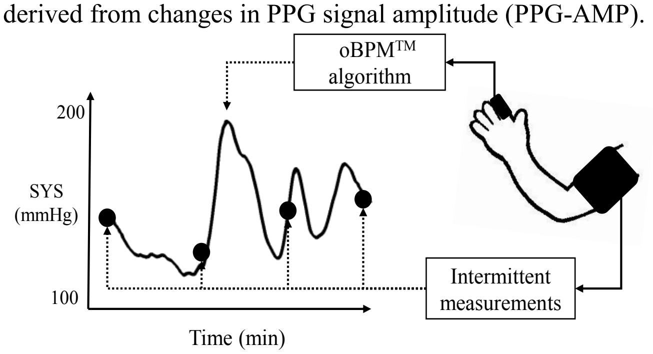

Figure 1. Detection of blood pressure changes during anesthesia via the re-analysis of pulse oximeter signals. The oBPM algorithms extrapolate intermitent measurements performed by automated oscillometric cuffs.

J. Solà, YM. Proença, F. Braun, C. Verjus, and M. Bertschi are with the CSEM S.A. - Centre Suisse d'Electronique et de Microtechnique, Neuchâtel, Switzerland (e-mail: Josep.Sola@csem.ch).

Y. Ghamri, N. Pierrel, and P. Schoettker with CHUV – Centre Hospitalier Universitaire Vaudois, CH-1011 Lausanne, Switzerland (email: Patrick.Schoettker@chuv.ch)

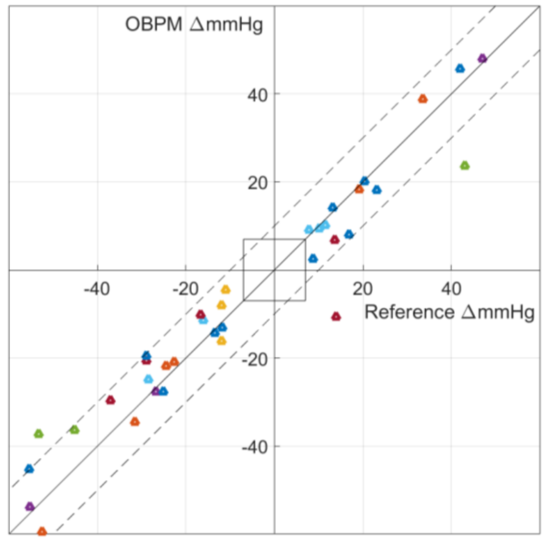

Figure 2. Performance of oBPM algorithms to detect BP changes from pulse oximeter signals, compared to measured invasive systolic changes.

Performance was evaluated in terms of concordance rate (the percentage of correctly-detected changes in BP trends), *ΔBP Error* (the error in predicting the amount of such BP changes), and *Accuracy ±Δ20mmHg* (the accuracy in detecting threatening changes of more than 20mmHg)

II. Results

Fig. 2 illustrates a four quadrant plot analysis of the reference and estimated blood pressure changes via the oBPM algorithms. Table 1 compares the performance of the oBPM algorithm and the naïve PPG predictions (N=36).

TABLE I. Performance of the oBPM Algorithms

BP algorithm	**Performances**		
	Concordance Rate	***ΔBP error (mmHg)***	***Accuracy Δ20mmHg***
oBPM algorithm	97%	0.3 ± 7.7	94%
Benchmark 1: PPG-HR prediction	56%	6 ± 22	58%
Benchmark 2: PPG-AMP prediction	47%	3 ± 28	50%

References

[1] J. Solà, "Continuous non-invasive monitoring of blood pressure in the operating room: a cuffless optical technology at the fingertip", Proceedings BMT2016, Basel, Switzerland, 2016, doi: 10.1515/cdbme-2016-0060

[2] M. Proença, "Method, apparatus and computer program for determining a blood pressure value", WO Patent WO/2016/138965