oBPM™—Optical Blood Pressure Monitoring: Performance in Anesthetized Patients

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The commercialization of smartwatches and smart bands is boosting the presence of optical sensors located at the wrist. Initially aimed at monitoring heart rate, such photoplethysmographic (PPG) sensors contain additional worthwhile information that is currently unexploited: in particular, concerning blood pressure. CSEM started ten years ago developing algorithms to extract cardiovascular information out of PPG signals. Initially at the chest, and later extended to other body locations, CSEM's optical blood pressure monitoring (oBPM™) solution offers a toolbox to enlarge the capabilities of PPG sensor devices, enabling breakthrough blood pressure (BP) monitoring functionalities. To differentiate from other competitors, CSEM is currently validating oBPM™ algorithms in a cohort of anesthetized patients including invasive reference means, and involving very challenging hemodynamic variations.

Several worldwide actors recently claimed methods to measure blood bressure (BP) from the analysis of photoplethysmographic (PPG) signals. To differentiate from such newcomers, CSEM positions itself in terms of reliable and clinically-supported results. In this context, CSEM focuses on providing performance figures of its proprietary optical blood pressure monitoring (oBPM™) solution in challenging environments, rather than biased and unrealistic laboratory experiments. An ongoing clinical study (NCT02651558) at CHUV, Lausanne University Hospital, currently assesses the accuracy of such oBPM™ algorithms when compared to invasive systolic BP measurements at the radial artery.

Figure 1 and Table 1 provide figures of merit for eight patients in the development dataset. The goal of the analysis is to demonstrate the performance of oBPM™ in detecting changes of BP induced by vasoactive anesthetic agents, compared to naïve predictions. In particular, concordance rate depicts the percentage of correctly-detected changes in BP trends, *ΔBP Error* depicts the error in predicting the amount of such BP changes, and *Accuracy ±Δ20 mmHg* depicts the accuracy in detecting threatening changes of more than 20 mmHg.

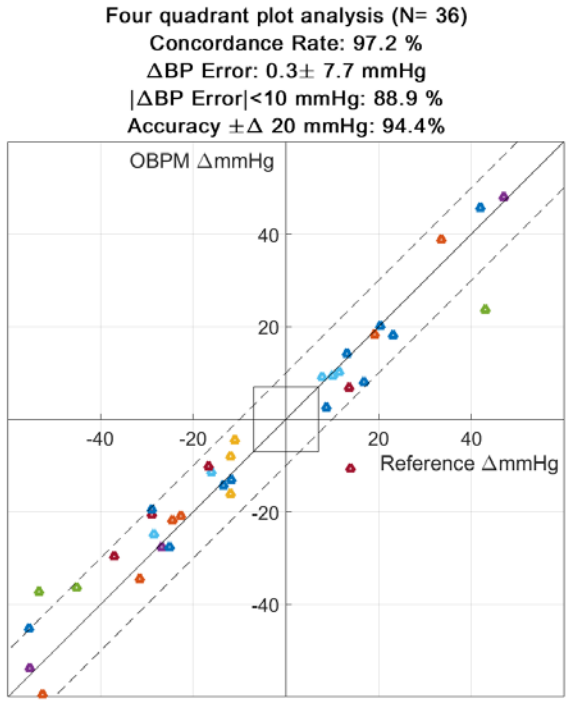


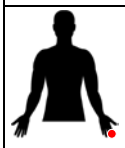
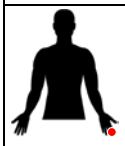
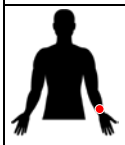
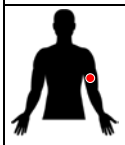
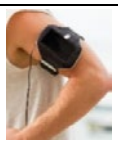
Figure 1: Performance of oBPM algorithms when applied to pulse oximeter signals of eight patients during anesthesia (N= 36 measurements). The reference are invasive systolic changes of BP.

Table 1: Performances of oBPM™ algorithms based on the analysis of PPG signals during anesthesia induction. PPG-HR depicts performance of an algorithm that estimates BP from heart rate changes. PPG-AMP depicts an algorithm that estimates BP from changes in amplitude of optical arterial pulsations.

	Concordance rate	**Δ**BP error (mmHg)	Accuracy **Δ20** mmHg
oBPM prediction	97%	0.3 ± 7.7	94%
Benchmark 1: PPG-HR prediction	56%	6 ± 22	58%
Benchmark 2: PPG-AMP prediction	47%	3 ± 28	50%

The tests performed on signals from pulse oximeters demonstrate the potential of oBPM™ in hemodanymic challenging conditions. CSEM prepares to transfer the oBPM™ technology to different commercial form factors (Table 2).

Table 2: Possible form factors of CSEM oBPM technology. TRL stands for Technology Readiness Level.

Location	Form factor	Application	TRL
		Continuous monitoring of BP trends during anesthesia	7
		Occasional ambulatory monitoring of BP via a smartphone camera	6
		Continuous ambulatory monitoring of BP via a smart bracelet	6
		Continuous ambulatory monitoring of BP via an armband	5