Smartphone-based Blood Pressure Measurement during Induction of General Anesthesia

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Hypertension, or chronically high blood pressure (BP), is the leading risk factor for cardiovascular diseases. With close to 1.5 billion hypertensive individuals globally, the need for accessible and accurate means of screening and monitoring BP is key in fighting this pandemic. Smartphones, which are widely available, could play a leading role. We have previously validated the accuracy and precision of the OptiBP® smartphone app (Biospectal, Switzerland), which runs CSEM's cuff-less BP monitoring algorithm. We present hereafter the trending ability of the app when tested in a very dynamic environment.

High blood pressure (BP), or hypertension, is the main risk factor for cardiovascular diseases and the root cause for approximately ten million deaths each year. By 2025, the number of people suffering from hypertension is expected to reach 1.5 billion. Early detection, prevention, and management of hypertension are essential, but require accessible and accurate measurements.

Smartphones represent widespread, readily available devices for mobile health, with over one third of consumers owning one worldwide. With the potential to measure a photo-plethysmographic (PPG) signal at the fingertip using the phone's camera and the recent advances in PPG-based BP monitoring [1], the potential of the approach is huge.

We have previously validated our patented cuff-less PPG-based BP monitoring algorithm [2] during general anesthesia induction using PPG signals from a standard pulse oximeter [3]. Using smartphone-derived PPG signals acquired via a dedicated app (OptiBP®, Biospectal, Switzerland), we have recently demonstrated [4] its compliance in terms of accuracy and precision with the requirements of the ISO 81060-2 standard. In the present study, our aim was to evaluate its trending ability (capability to track changes in BP).

In a clinical study [5] (ClinicalTrials.gov identifier: NCT03875248, Arm 1) in 121 patients scheduled for an elective surgery necessitating general anesthesia, we evaluated the trending ability of our BP algorithm applied to smartphone-derived PPG signals compared to invasive radial BP. One-minute PPG signals were measured every 2 minutes with the app and one BP value was estimated from each one-minute PPG signal. The corresponding synchronous reference BP value was calculated by averaging the invasive BP measurement during that minute. Clinically significant BP changes of at least ±15% occurring between one-minute windows were automatically identified in the PPG and invasive data. The trending ability was assessed via four-quadrant and polar plots, using the concordance rate (CR), the angular CR at ±30°, and the angular bias and standard deviation (SD) as trending performance metrics.

Figure 1 shows the results for mean BP. The upper panel (four-quadrant plot) depicts good concordance (CR = 95%). The lower panel (polar plot) confirms said concordance (angular CR at ±30° of 92%), with an angular bias ±SD of −2.0° ±17.2°. By analogy with non-invasive cardiac output monitoring techniques, good trending ability can be claimed with CR > 90-95%, angular CR at ±30° > 90-95%, and angular bias < ±5° [6]. Similar figures were obtained for systolic BP (CR = 91%, angular CR = 90%, angular bias and SD = −2.2° ± 18.8°) and diastolic BP (CR = 93%, angular CR = 92%, angular bias and SD = −0.2° ± 17.1°).

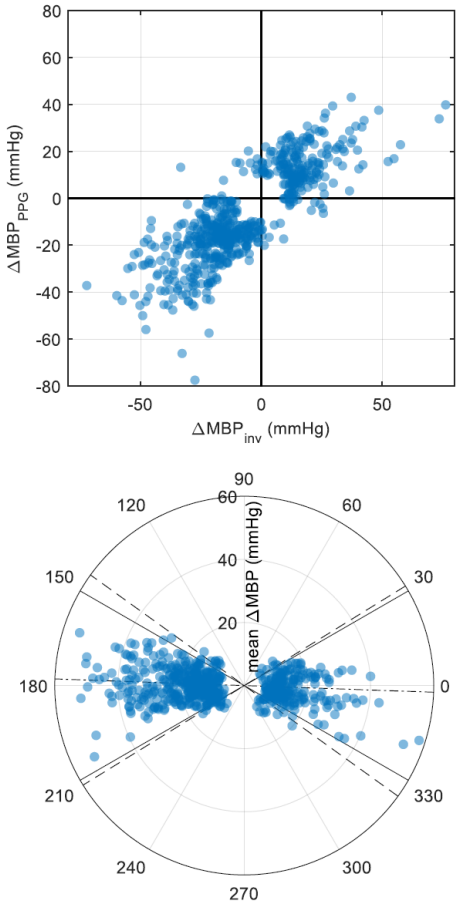

Figure 1: Four-quadrant plot and polar plot demonstrating the trending ability of the cuff-less BP algorithm for mean BP (MBP). The dash-dotted line in the polar plot depicts the angular bias, and the two dashed lines the 95% confidence interval.

Our study demonstrates that our cuff-less BP solution, applied to smartphone-derived PPG signals, can accurately track significant BP changes in challenging hemodynamic conditions. Being ISO 81060-2 compliant in static conditions, the smartphone implementation of our BP solution may become a key tool in the prevention and management of hypertension.

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