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LONG-TERM VALIDATION OF A BLOOD PRESSURE SENSOR AT THE CHEST

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Abstract: *A long-term validation of a novel technology to measure Blood Pressure (BP) at the chest is summarized in this abstract.*
A total number of 15 subjects participated in a two weeks experiments involving simultaneous measurement of BP via a brachial oscillometric device, and the novel chest sensor.
The cumulative percentage of Mean Arterial Pressure (MAP) values provided by the chest sensor falling within a range of ±5 mmHg compared to reference MAP readings was of 70%, within ±10 mmHg was of 91%, and within ±15mmHg was of 98%.
The novel chest technology offers a new approach to assess BP continuously without interfering with patients' life style.

Keywords: *blood pressure, non-invasive, non-occlusive, pulse wave velocity, chest sensor*

Introduction

The clinical demand for a device to monitor Blood Pressure (BP) in ambulatory scenarios with minimal use of inflation cuffs is increasing. Based on the so-called Pulse Wave Velocity (PWV) principle, this abstract summarizes the results of a long-term study involving a novel concept of BP monitor that can be fully integrated within a chest sensor. After a preliminary calibration, the sensor provides non-occlusive beat-by-beat estimations of Mean Arterial Pressure (MAP) by measuring the Pulse Transit Time (PTT) of arterial pressure pulses travelling from the ascending aorta towards the subcutaneous vasculature of the chest. A full description of the presented study is provided in [4].

Methods

A wearable system to monitor the PWV of central arteries was already reported in [1] and [2]. So-called chest sensor, the technique relies on the estimation of the Pulse Transit Time (PTT) of pressure pulses travelling from the aortic valve towards the cutaneous vasculature on the sternum. Figure 1 summarizes the working principle of the sensor. A full description of the implemented technologies is provided in [3] and [4].

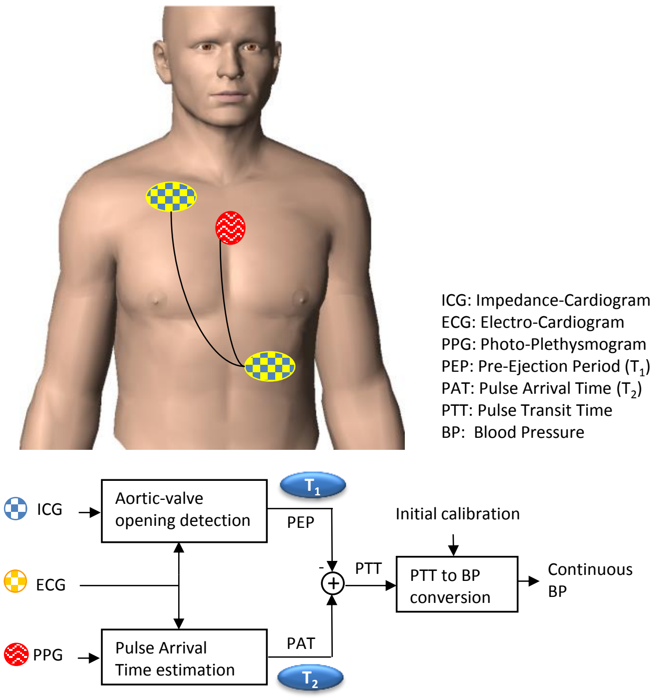

Figure 1: Measurement strategy for the chest BP sensor. Continuous, non-occlusive and unsupervised BP values are estimated via three technologies: ECG, ICG and PPG. Blue-yellow patches perform simultaneous ECG and ICG measurements, and contain two measurement electrodes each. The red patch is dedicated to multi-channel PPG measurements. T_1 depicts the opening time of the aortic valve, and T_2 depicts the arrival time of a pressure pulse at the subcutaneous vasculature of the sternum.

Results

In a cohort of 15 healthy male subjects, a total of 462 simultaneous readings consisting of reference MAP and chest PTT were acquired. Each subject was recorded at three different days: D, D+3 and D+14. Overall, the implemented protocol induced MAP values to range from 80 ± 6 mmHg in baseline, to 107 ± 9 mmHg during isometric handgrip maneuvers (see Figure 2).
Different calibration strategies were tested in order to map chest PTT (in ms) to MAP values (in mmHg). A description of the studied strategies is provided by [4].

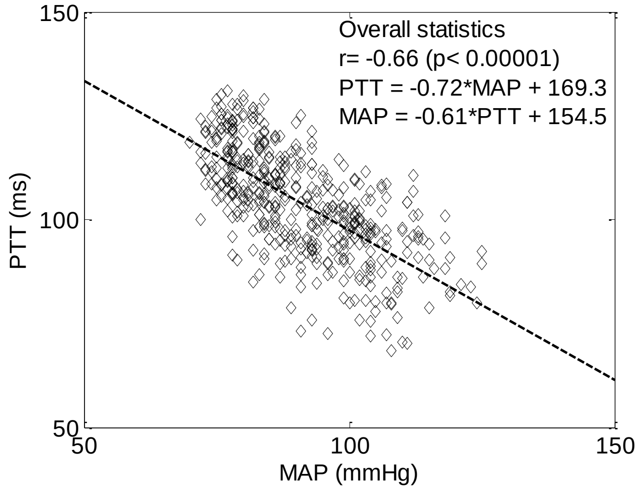

Figure 2: Overall correlation analysis between Pulse Transit Time (PTT) and Mean Arterial Pressure (MAP) for all subjects enrolled in the validation study. The analysis includes 462 measured values, corresponding to all cardiovascular conditions and recording days. Overall regression analysis between PTT and MAP is provided as well.

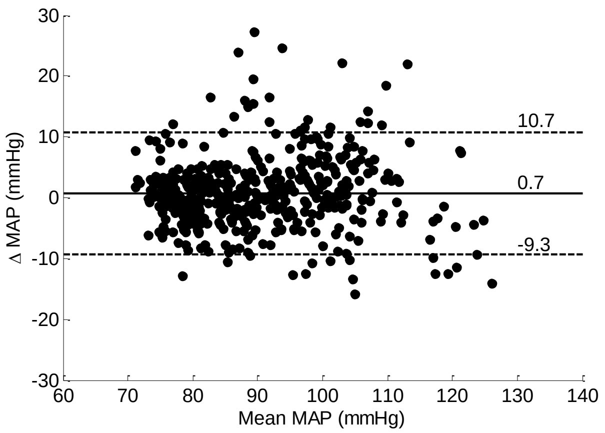

Figure 3: Overall Bland-Altman analysis when comparing oscillometric MAP values against chest-sensor estimates (N=462).

Agreement between reference and chest-sensor MAP values was tested by using Bland-Altman analysis (mean error = 0.7 mmHg, standard deviation = 5.1 mmHg) as depicted by Figure 3. The cumulative percentage of MAP values provided by the chest sensor falling within a range of ±5 mmHg compared to reference MAP readings was of 70%, within ±10 mmHg was of 91%, and within ±15mmHg was of 98%. These results point at the fact that the chest sensor complies with the British Hypertension Society (BHS) requirements of Grade A BP monitors, when applied to MAP readings. Grade A performance was maintained even two weeks after having performed the initial subject-dependent calibration.

Figure 4 illustrates three examples of subject-dependent performance of the novel chest BP sensor.

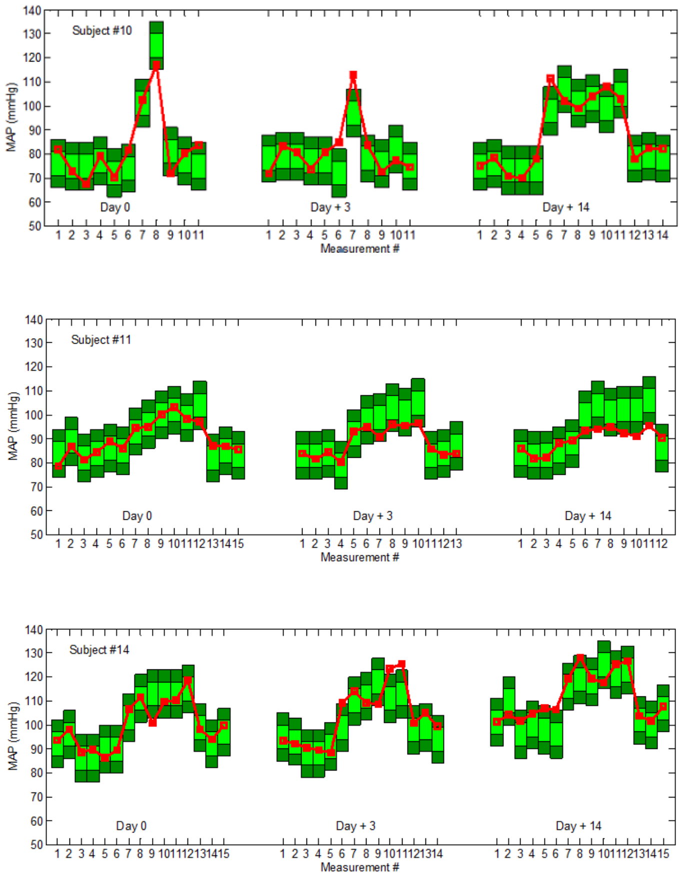

Figure 4: Three examples of the performance of the BP chest sensor. Red curves depict MAP as estimated by the chest sensor. Light boxes comprise reference MAP by an oscillometric device ±5 mmHg, and dark boxes reference MAP ± 10 mmHg.

Conclusions

In conclusion, this paper introduces a sensor and a calibration strategy to perform MAP measurements at the chest. The encouraging performance of the presented technique paves the way towards an ambulatory-compliant, continuous and non-occlusive BP monitoring system.

References

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