Cuffless Blood Pressure Monitoring: CSEM's Portfolio of Non-occlusive Technologies

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During the last 10 years CSEM has intensively worked on the development of an innovative catalog of technologies that enable the monitoring of blood pressure in a comfortable and continuous manner. Either located at the chest or the wrist, these technologies open the door to a new era of cuffless blood pressure monitoring: improving patient's comfort and increasing the number of measurements per day. Several clinical validation studies are currently in progress, and a dedicated patent portfolio is available for licensing.

The non-invasive measurement of blood pressure in clinical practice is currently limited to the use of an inflation brachial cuff, providing only intermittent and uncomfortable readings of blood pressure. The race for alternative technologies that increase patient's comfort while providing actual 24/24h readings to physicians has started worldwide. The reward of the race will be a first-in-the-market wearable blood pressure monitor[1]. In this technological race, CSEM's contribution resides on the introduction of two families of technologies (see Figure 1):

- A) chest-based technology relying on the analysis of optical and bioimpedance signals. Matching the needs of wearable systems, this technology estimates central continuous blood pressure values via the so-called Pulse Wave Velocity principle[2].
- B) wrist-based technology relying on the analysis of optical signals. Matching the needs of smartwatches, this technology estimates peripheral blood pressure values via a proprietary analysis of arterial pulsatility patterns (physiological Pulse Wave Analysis)[3].

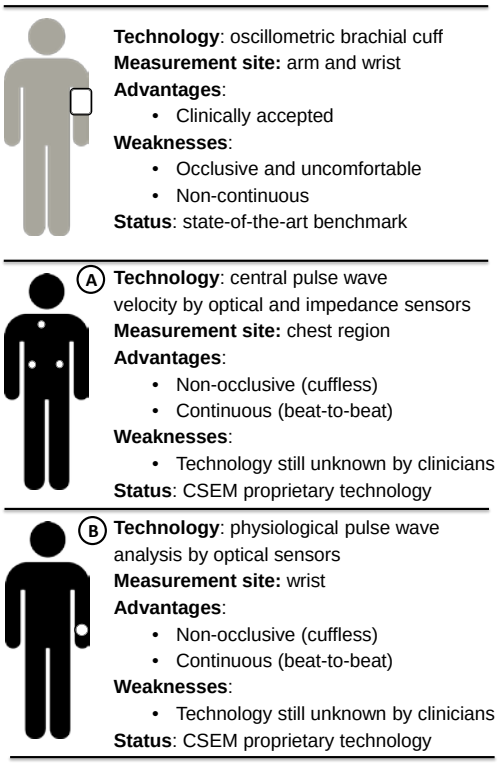

Figure 1: Summary of state-of-the-art and CSEM technologies for the non-invasive measurement of blood pressure.

Figure 2 illustrates the results of two pre-clinical studies involving healthy volunteers (*N*=30) when comparing CSEM's cuffless blood pressure estimations (vertical axis) to reference blood pressure values (horizontal axis). Different subjects are illustrated represented by different markers. Note that for both pre-clinical studies, cuffless blood pressure estimates correlate to the measured occlusive values, providing agreement scores that comply with AAMI and BHS standards.

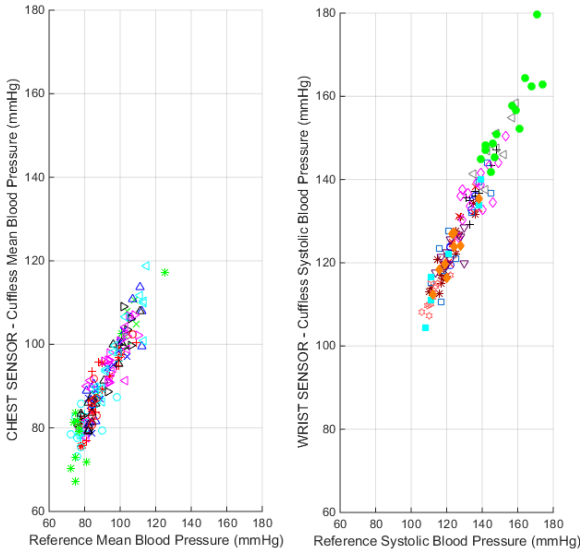

Figure 2: Correlation plots for cuffless versus reference blood pressure values for CSEM chest-based (left) and wrist-based (right) technologies.

Current efforts of CSEM's research team are put on in-depth clinical validation of these innovative cuffless technologies in different Swiss University hospitals. The implemented clinical studies involve a large palette of scenarios, ranging from anesthetized patients in the operating room to hypertensive patients in ambulatory settings.

The dedicated technology and patent portfolio differentiates CSEM as a key international player for the development of new blood pressure sensors for the wearable market.

[1] Mukkamala *et al.*, Towards Ubiquitous Blood Pressure Monitoring via Pulse Transit Time: Theory and Practice, IEEE TBME, 62(8), 2015.

[2] Solà *et al.*, Non-invasive and non-occlusive blood pressure estimation via a chest sensor, IEEE TBME, 60(12), 2013.

[3] Nichols *et al.*, McDonald's Blood Flow in Arteries: Theoretical Experimental and Clinical Principles, CRC Press, 2011.