

# New methods to monitor patient health via a blood pressure cuff

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Hemodynamic monitoring is critical when it comes to the treatment of patients at risk of hemodynamic instability. Assessment of the

hemodynamic status can be achieved by measuring a number of vital signs using sensors. In recent times, significant improvements have been achieved, with monitoring technologies becoming safer and more accurate. However, limitations remain that stem from the need to obtain a more complete picture of the hemodynamic status as standard vital signs don't always reveal when patient deterioration occurs. For her Ph.D. research, Laura Bogatu addresses these limitations by proposing new theory and experimental tests to perform additional measurements using blood pressure cuffs.

In hemodynamic or blood flow [monitoring](#), uncertainty remains in the interpretation of common variables such as blood pressure (BP). Even when an accurate BP value is recorded, it is still a late indicator of health deterioration. Controversy exists in the clinical community regarding the definition of a healthy BP range. Additional hemodynamic information would help identify the original causes leading to instability—e.g., differentiating between heart related factors or vasodilation.

It is also recognized that patient deterioration is detected too late in low-acuity monitoring settings; the wards requiring the most urgent improvement. At the same time, existing ward measurements lead to frequent unspecific alarms, with a false alarm rate of 90%, thus showing the challenge of monitoring unstable patients.

## **Reviewing the state-of-the-art**

In her Ph.D. research, Laura Bogatu proposes a new theoretical framework and experimental tests to broaden the set of parameters that can accurately be monitored with standard clinical equipment.

To determine the limitations of the state-of-the-art monitoring technology in relation to the clinical needs, she first reviewed and evaluated the main trends in [critical care](#) for the measurement of new

hemodynamic parameters. The current research approaches, opinions, and protocols are analyzed from both a clinical and a technical perspective.

The review confirms that existing patient monitoring devices might not be used to their full potential and that several opportunities exist for acquiring additional hemodynamic information to improve measures like BP with standard BP cuffs. Standard equipment is preferred over advanced novel technologies to accelerate the clinical translation and uptake of the developed methods.

## **New sensor arrangements**

Bogatu explored a number of underutilized arrangements of standard sensors to collect additional information on compensatory mechanisms of the circulation.

For example, she studied [arterial stiffness](#)/compliance parameters, which are researched in the context of cardiovascular disease management, but overlooked in hemodynamic monitoring. Nevertheless, critical-care clinicians have expressed interest in having these parameters when it comes to making decisions on treating patients.

In the thesis, Bogatu outlines a new measurement strategy to assess brachial arterial compliance by fusion of sensors for arterial pressure-volume (acquired via cuff-based oscillometry) and pulse wave velocity (PWV) (estimated via combination of electrocardiographic and photoplethysmographic signals). The sensor fusion minimizes measurement inaccuracy expected in a hemodynamic monitoring environment.

## **Blood pressure cuff evaluation**

In addition, Bogatu looks at practical aspects of the implementation of the measurement strategy. While simulations, theory, and physiological insights from patient data are needed to develop effective measurement strategies, the implementation of these measurements in [clinical practice](#) requires in-depth understanding of the [blood pressure](#) cuff transducer characteristics and patient-specific, arm-tissue properties. These characteristics and properties are typically assumed to be ideal, with negligible impact on cuff-based measurements; as a result, they are largely overlooked.

Therefore, Bogatu and her colleagues verify the validity of the assumptions that are made with regards to the cuff transducer and arm tissue characteristics via a series of studies involving MRI imaging, tensile tests conducted on typical cuff materials, and measurement of the cuff response to mechanically simulated arm pulsations under various conditions.

In summary, Bogatu finds that the common BP cuff is largely underutilized, while it offers ample possibilities to modulate the blood flow and pulse propagation along the artery, revealing dynamic/compensatory mechanisms of the circulation.

With her proposed setup, she obtains a more advanced characterization of the circulatory system response to occlusion perturbations and, based on this, developed several measurement strategies to enable the estimation of previously inaccessible parameters (vascular tone, peripheral resistance, artery-vein interaction, vascular collapse mechanics, arterial viscosity).

Future work will investigate whether the availability of more parameters provides a better description of the hemodynamic status and if these can result in improved patient outcomes.

**More information:** Enhanced model-based assessment of the hemodynamic status by noninvasive multi-modal sensing.  
[research.tue.nl/en/publication ... hemodynamic-status-by-noninvasive-multi-modal-sensing](https://research.tue.nl/en/publication/.../hemodynamic-status-by-noninvasive-multi-modal-sensing)

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