VRIJE UNIVERSITEIT BRUSSEL

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DOCTOR OF ENGINEERING SCIENCES

of **Salar Tayebi**

The public defense will take place on **Tuesday 21st April 2026 at 5pm** in room **D.2.01** (Building D, VUB Main Campus)

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BEYOND CONVENTIONAL METHODS FOR THE CHARACTERIZATION OF INTRA-ABDOMINAL PRESSURE

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Abstract of the PhD research

This PhD thesis investigates how pressure inside the abdomen, known as intra-abdominal pressure (IAP), can be better understood and monitored, particularly in critically ill patients. Elevated IAP is a clinically important condition: when IAP rises beyond normal levels, it can impair organ function and, in severe cases, lead to life-threatening complications. For this reason, there is growing recognition that IAP should be monitored more systematically, similar to other vital signs in intensive care. The thesis begins by outlining the mechanisms that lead to increased abdominal pressure. IAP can rise either because the abdominal cavity becomes less compliant or because its internal volume increases, often due to fluid accumulation during severe illness. Increases in abdominal pressure can influence other body compartments, including the chest and the brain, highlighting the systemic nature of the problem. From a physical perspective, the abdomen is described as a semi-enclosed compartment bounded by both rigid and flexible structures. The thesis then reviews current techniques for measuring IAP. Clinically, IAP is most commonly assessed indirectly via the urinary bladder, which serves as a reference standard. However, this method is intermittent and not ideally suited for continuous monitoring. As a result, there is increasing interest in alternative approaches that estimate IAP non-invasively, for example by analyzing changes in body shape or tissue mechanics. To explore this, the thesis examines the relationship between IAP and anthropometric parameters in a cohort of intensive care patients. The results show that specific body measurements are associated with IAP. These findings support the idea that externally measurable changes in body geometry may serve as useful indicators of internal pressure. Building on this concept, the thesis investigates microwave reflectometry as a novel non-invasive method for IAP monitoring. This technique uses low-power electromagnetic waves to probe the abdominal wall and detect structural changes. Through a combination of computational models, laboratory experiments, and clinical studies, the work demonstrates that changes in abdominal wall displacement can be reliably captured. In particular, the time of flight of reflected signals emerges as a robust parameter for tracking IAP-related changes. Finally, the thesis addresses an important practical issue: the dependence of IAP measurements on body position and measurement site. Clinical studies show that IAP values can vary significantly with posture and with the location of measurement, emphasizing that IAP is not a fixed quantity but a context-dependent parameter. In summary, this thesis provides an integrated understanding of intra-abdominal pressure from physiological, methodological, and technological perspectives. It highlights the limitations of current measurement techniques and presents non-invasive alternatives that could enable more continuous and patient-friendly monitoring in the future.