BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

DIMEAS/CRT - Biomechanics-powered support system for ascending thoracic aortic aneurysms management

Funded By	DIMEAS - Progetti ricerca MIUR e altri ministeri FONDAZIONE CRT CASSA DI RISPARMIO DI TORINO [P.iva/CF:06655250014]

Supervisor	GALLO DIEGO - diego.gallo@polito.it

Contact	MORBIDUCCI UMBERTO - umberto.morbiducci@polito.it CALO' KAROL - karol.calo@polito.it

Context of the research activity	An ascending thoracic aortic aneurysm (aTAA) is a life threatening permanent dilatation of the aorta. To avoid fatal complications such as aortic dissection and rupture, surgical elective repair of aTAA is recommended when the aTAA maximum diameter reaches a critical size (55mm). However, this criterion leads to risk of adverse events around 5% and risk of type A aortic dissection of around 60%, highlighting the need for defining more robust and mechanistic-based criteria.

Objectives	Biomechanical indicators based on computational modelling of blood flow dynamics and wall mechanics have been proposed, but their clinical utility is hampered by the high computational cost, model complexity/assumptions/idealizations and technical expertise from the end user. Moreover, they often fail to combine information from different sources ranging from the molecular to the organ level. The PhD project will integrate demographic information, clinical and imaging parameters, biomarkers data, biomechanical modeling and morphologic aTAA shape features to build robust predictive models. Leveraging artificial intelligence and computational biomechanics methods, the objectives are to (i) predict the risk of adverse events like rupture and dissection and (ii) estimate the aTAA growth trajectory. The project will generate new knowledge on the mechanistic understanding of aTAAs, at the same time laying the foundations for a “digital patient” technology by which physicians will reap the benefits of a novel paradigm of predictive and personalized medicine. The outcome of this project will unlock unprecedented levels of accuracy in identifying high-risk or high-cost patients, facilitating a more effective and efficient care. In detail, a smooth and efficient data processing workflow will be designed and developed with the aim of obtaining, processing and analyzing patient-specific information with times compatible with the clinical framework. Data

	include multi-dimensional, structured and unstructured health data such as demographic information, clinical and imaging data, cellular, genetic and molecular biomarkers, structural and fluid dynamic descriptors, morphological aTAA shape features. Then, a digital twin framework will be developed by integrating and augmenting experimental, clinical and computational data to enable/exploit the identification of mechanisms and/or the prediction of outcomes. The digital twin framework will implement advanced hemodynamic analyses in a patient-specific approach to study the biomechanics of aTAA. Realistic patient-specific structural and flow conditions will be integrated in a fluid-structure interaction (FSI) model.

Skills and competencies for the development of the activity	Candidates should have experience in: cardiovascular biomechanics; computer programming; biomechanical analysis; computational fluid dynamics; fluid-structure interaction. Candidates should be independent and self-motivated, with scientific creativity and originality, strong team spirit and collaborative capacity, excellent time management, rigour, perseverance, strong writing skills. Fluency in English is mandatory.