Politecnico di Torino

Call for PhD Position – Politecnico di Torino

Cerebral fluid dynamics: an integrated clinical-computational approach to investigate the link between atrial fibrillation and dementia

Atrial fibrillation (AF), characterized by an irregular heart rhythm, is the most common cardiac arrhythmia, counting nearly 60 million prevalent cases worldwide in 2019 and with epidemiological projections foreseeing a further rise during the next decades. Dementia is a progressive neurological degeneration leading to decline in memory, reasoning, communication, and capacity to carry out daily activities, which currently affects more than 50 million people worldwide and with 150 million cases estimated in 2050. Both diseases share several common risk factors, many of which are modifiable, except for age and genetic factors. Through a constellation of potential underlying hemodynamic mechanisms - such as silent microembolic cerebral infarctions, altered cerebral blood flow, hypoperfusion and microbleeds - there is growing evidence that AF is independently associated with an increased risk of dementia and cognitive impairment, even in the absence of clinical strokes. However, causality mechanisms have not been established yet, and the impact of AF treatments on dementia development is far from being clear. Among the possible contributors, the hypothesis of an altered cerebral blood flow due to the AF irregular beating is the most intriguing and the least investigated. The complex interplay between pressure-flow wave propagation in a network of tapered viscoelastic vessels with different size and the irregular pulsatile flow makes AF effects on the brain microcirculation presently unknown. In fact, currently adopted clinical techniques to assess cerebral hemodynamics *in vivo*, such as transcranial Doppler and magnetic resonance imaging (MRI), lack the resolving power to provide insights on the deep cerebral regions.

The proposed PhD project is a joint and interdisciplinary collaboration between Politecnico di Torino (Prof. S. Scarsoglio and L. Ridolfi, DIMEAS/DIATI, Polito BioMedLab) and the University of Turin (Prof. M. Anselmino, Cardiology Unit of the “Città della Salute e della Scienza di Torino” Hospital), and is funded by the Italian Ministry of University and Research. The main goal is to understand and computationally quantify mechanistic AF-induced effects on the cerebral microcirculation underlying the association between AF and cognitive decline. Thus, our research proposal aims to contribute at filling the gaps in the pathophysiological knowledge of the cerebral hemodynamics during AF and providing scientific evidence to improve clinical AF management in order to reduce the impact on cerebral circulation. In this respect, a delay of the onset of dementia by just few years would have huge socio-economic implications, in terms of the patient’s quality of life and burden of health care costs. The present topic has a huge medical relevance due to the AF increasing prevalence in the population and, at the same time, its accurate modeling is extremely challenging both from the fluid dynamics and mathematical viewpoints. The PhD candidate will deal with the implementation and numerical simulation of mathematical models (of different orders and level of details) of the cerebral circulation. The skills required are of mathematical-computational kind, with particular attention to the modeling and simulation of hyperbolic equations in one-dimensional complex domains (i.e., networks of arterial vessels), multiscale modeling, and analysis of complex systems. The possible knowledge of the fluid dynamics phenomena connected to the cardiovascular system as well as previous experience in computational hemodynamics, although not necessary, constitute preferential titles. The PhD fellowship lasts 3 years, with tentative starting date March 1st, 2024 (application from 02/11/2023 to 20/11/2023).

Contacts

Prof. Stefania Scarsoglio (stefania.scarsoglio@polito.it)
Prof. Luca Ridolfi (luca.ridolfi@polito.it)