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# MULTI-MODALITY ANALYSES OF BLOOD FLOW

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## ABSTRACT

Quantitative analyses of blood flow dynamics play a major role in diagnostics and treatment planning of cardiovascular disease. Hemodynamics phenomena can be assessed in vivo with medical imaging or by image-based models, either in silico (computational) or in vitro (experimental). In vivo imaging techniques, such as phase-contrast MRI (4D Flow MRI) are capable of providing time-resolved, three-directional velocity fields [1], however 4D Flow MRI can be affected by limited spatiotemporal resolution and velocity dynamic range, as well as image artefacts and noise. In silico models provide superior resolution but rely on assumptions and simplifications that may affect the fidelity of the results.

Imaging and modelling approaches have different source of errors and biases; however, these approaches provide complementary results and information, which can be combined to improve the accuracy of flow-derived variables linked to cardiovascular disease. Recent advancements in both imaging and computational methods allowed substantial progress in subject-specific flow analysis [2], however there is still a gap between these approaches, as well as a lack of communication between the MRI and computational modelling communities. Bringing together the experts in both fields will facilitate collaboration and development of multi-modality methods for hemodynamic analysis, including computational approaches towards patient-specific hemodynamics [3].

In this minisymposium, we propose to gather a set of experts to address the advantages and limitations of the different flow quantification modalities, to discuss state-of-the-art techniques in image-based modelling and to consider novel methods for integrating imaging and modelling

data. In particular, we welcome contributions addressing the applications of artificial intelligence (AI) based methods for analysis/post-processing of imaging data in order to provide input into computational models, thus using data-driven computations for patient-specific treatment planning. The large amount of imaging and modelling data now available to researches makes machine-learning and AI approaches to multi-modality analyses of blood flow a feasible and promising direction of research.

The topics of the minisymposium include but are not restricted to:

- Image-based computational fluid dynamics (CFD) models of cardiovascular flow
- Computational tools for multi-field (e.g., fluid–structure) patient-specific modelling
- Comparison and synthesis of flow imaging and computational results
- Verification and validation of imaging and numerical flow fields
- Algorithms for denoising and improving flow imaging data
- Machine-learning methods for enhancing flow imaging and analysis

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