

BIOMECHANICS, MECHANOBIOLOGY AND TRANSLATION IN THE HEART

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MINI-SYMPOSIUM PROPOSAL

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Heart and cardiovascular diseases continually challenge modern medicine, placing a strain on healthcare systems worldwide. Heart disease aetiology is often complex, multifactorial, and dependent on other organ systems, requiring tailored treatment plans. Exacerbating this challenge is the complexity of cardiac structure, function and mechanobiology all of which play a significant role in maintaining cardiac output.

Computational modeling is actively being pursued as a tool for accelerating research, understanding fundamental physiology and improving translation [1]. Enabling the exploration of the relationships between different physical mechanisms, multiscale phenomena and function, computational modeling provides a viable platform for improving patient outcomes. However, successful exploitation of computational modeling in the heart demands integration of core technologies and knowledge spanning a broad spectrum of disciplines. Addressing the multitude of challenges facing translation in the heart requires advancement of biomechanical modeling in a diverse, yet complementary, array of subjects. This mini-symposium seeks to review the latest state-of-the-art topics including:

- **Biophysical / constitutive models:** Models with varying degrees of granularity, capable of providing diagnostic and prognostic assessments of cardiac function. This includes detailed cell models incorporating biophysical phenomena observed in vitro, tissue-level models capturing the biomechanics of heart muscle, as well as models capable of describing the structural and functional growth and remodeling of cardiac tissue.
- **Physics-based models:** Models capable of characterizing important physical phenomena driving the human heart. This includes single-physics and multi-physics models capturing the biomechanics, electrophysiology, blood-flow and perfusion.

- **Whole-Organ models:** Built-for-purpose computational models that incorporate relevant model constituents required to address fundamental questions regarding the physiology and pathophysiology of the human heart.
- **Numerical Methods / Analysis:** Accurate and rigorous numerical techniques that enable the efficient and stable uptake of these models for use in the evaluation of patient-specific cardiac function, device design or therapy planning. These include novel techniques for numerical discretization, efficient solver technologies, use of novel and emerging hardware / software, methods for multi-physics integration as well as novel mathematical analysis of the model stability and robustness.
- **Data Assimilation:** Design of methodologies, modeling strategies, and image processing pipelines for effectively harnessing the information coming from clinical data. This includes efficient methods for data assimilation and model personalization, approaches to effectively manage model fidelity and parameter identifiability, and pipelines for adapting model morphology and boundary conditions based on clinical data.
- **Translational models:** Personalized patient-specific models that effectively accumulate and condense the wealth of data, models, and techniques to deliver clinically relevant tools for diagnosis and/or therapy planning.

The aim of this mini-symposium is to provide a forum highlighting the latest developments in these disparate, yet synergistic, emphasis areas as well as outline current challenges. Collecting broadband expertise, this symposium will give attendees a clear vision of the landscape of biomechanics, mechanobiology and translational research in the heart. The symposium will also provide a unique environment for cross-talk, enabling the sharing of novel ideas and expertise necessary for the future advancement of biomechanical modeling in the heart.

REFERENCES

- [1] Chabiniok, Radomir, et al. *Multiphysics and multiscale modeling, data–model fusion and integration of organ physiology in the clinic: ventricular cardiac mechanics*. Interface focus, 6.2, 20150083, 2016.