6th International Conference on Computational and Mathematical Biomedical Engineering – CMBE2019
10–12 June 2019, Japan
P. Nithiarasu, M. Ohta and M. Oshima (Eds.)

# TRANSLATING CARDIOVASCULAR MATHEMATICS TO THE BEDSIDE

**Ferdinando Auricchio*, Alison L. Marsden†, Rodrigo M. Romarowski# and Alessandro Veneziani§**

* Dept. of Civil Engineering and Architecture, University of Pavia. Via Ferrata 3, Pavia, Italy. auricchio@unipv.it †Dept. of Bioengineering, Stanford University. 318 Campus Dr, Stanford, CA, USA. amarsden@stanford.edu #3D and Computer Simulation Laboratory, IRCCS Policlinico San Donato. Via Morandi 30, San Donato Milanese, Italy. rodrigo.romarowski@grupposandonato.it §Dept. of Mathematics and Computer Science, Emory University. 400 Dowman Dr., Atlanta, GA, USA. ale@mathcs.emory.edu

**MINI-SYMPOSIUM PROPOSAL**

**Keywords:** *Cardiovascular Science, Numerical Modeling, Medical Imaging, Inverse Problems, Fluid- Structure Interaction, Computer Aided Clinical Trials, Surgical Planning*

## 1 STATEMENT OF PURPOSE

“Computational modeling, [...], could revolutionize the field of medical devices by predicting how a device will perform” [1]. This statement comes from the US Food and Drug Administration (FDA) and witnesses the perception of professionals about the role of technologies based on mathematical and numerical modeling in healthcare. After decades of numerical modeling oriented at understanding basic physiopathology, the biomedical and the healthcare industries are moving toward the use of such methods in practice, at a much larger scale. As a possible example, we mention the company HeartFlow, currently FDA approved and on the market for the non-invasive estimation of a clinical index called Fractional Flow Reserve.

While an extensive use of numerical models and methods in the diagnosis/prognosis/therapy of cardiovascular diseases (the leading cause of death in the Western Countries), is commonly considered beneficial, its penetration into the clinical practice is slowed by several factors (at a scientific and generally cultural level) and most importantly methodological challenges. More specifically, we indicate two clinical activities that may benefit the most from an extensive use of Cardiovascular Mathematics, namely Clinical Trials (CT) and Surgical Planning (SP), the former as a source of certified and reliable information, the latter as a decision-making process.

The successful solution of those new challenges relies on strongly interdisciplinary teams with a continuous information exchange among the different components, mathematicians, computer scientists, biomedical engineers and medical doctors. In this mini-symposium, we aim at sharing experiences where numerical simulations have been done by the bedside, where the whole pipeline has demonstrated a relevant clinical impact. Particular focus will be made in studies where a big number of patients were enrolled to analyze hemodynamics in different parts of the cardiovascular system, and in-silico therapies at different stages of their application. Start-up and entrepreneurial initiatives in this field will be considered as well.

## 2 TOPICS

We identify a number of specific topics and challenges that will be covered in the Mini Symposium as they are critical for the successful deployment of scientific computing aided methodologies and technologies in the clinical practice.

1. Development: current software trend and capabilities in image processing, numerical simulations and post-processing.
2. Efficiency (toward real-time): Model reduction in computational hemodynamics and experiences with high performance computing.
3. Reliability: Uncertainty quantification, defective data sets and data assimilation with a focus in the translational component of the research.
4. “Plug’n’play” tools: (semi-)automatic workflows in clinical trials: success cases and current challenges.
5. Fluid-Structure Interaction in clinics: why, when and how.

The Minisymposium is open to both experts and junior researchers working at any stage of the simulation pipeline involved in cardiovascular districts such as: the aorta (aortic dissections, thoracic and abdominal aneurysms, coarctations, endovascular technologies), coronary arteries (congenital malformations, atherosclerosis), peripheral vasculature (open and endovascular techniques) and the venous system.

At the end of the mini-symposium we plan to run a short summary session, trying to draw the most relevant indications resulting from the scientific discussions and to identify a possible roadmap for a systematic use of scientific computing in clinics, including educational aspects. If time allows, one slot of the mini-symposium will be dedicated to speed-dating between senior and junior scholars involved in the field.

The support of the US NSF DMS-1620406 is greatly acknowledged.

## REFERENCES

[1] Food and Drug Administration (FDA), Regulatory Science in FDAs Center for Devices and Radiological Health: a vital framework for protecting and promoting public health, http://www.fda.gov/downloads/aboutfda/centersoffices/cdrh/cdrhreports/ucm274162.pdf, 2011.