

CARDIOVASCULAR MATHEMATICS: FROM THE COMPUTER ROOM TO THE BEDSIDE

Emory Task Force in Cardiovascular Mathematics*, **Beta-Lab**[†]

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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 noninvasive 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. The proponents of this MiniSymposium work in facilities gathering all these ingredients at a close distance. The Emory Task Force of the Department of Mathematics and Computer Science, led by Alessandro Veneziani (with Adrien Lefieux, Boyi Yang, Huijuan Xu, Sofia Guzzetti, Alessandro Barone, Ricardo Bonilla Alicea, Alexander Viguierie) works in strict cooperation with Clinicians of the Emory University Hospitals (Habib Samady, Brad Leshnowar, Frank Tong) and Biomedical Engineers of GA Tech (Don Giddens, Ajit Yoganathan, Manu Platt). Beta-Lab in Pavia, led by Ferdinando Auricchio (with Alessandro Reali, Michele Conti, Simone Morganti), works in strict cooperation with the Hospital and Research Institution San Donato, in Milan (Santi Trimarchi, Massimo Marrocco, Francesco Secchi).

In this MiniSymposium, we aim at gathering other experts and groups in the World working in similar frameworks to discuss state-of-the-art methodologies and solutions leading to a massive introduction of computer aid in CT and SP.

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. The clinical perspective: current and future challenges in cardiovascular sciences from clinicians standpoint .
2. Is real-time computation possible? Model reduction in computational hemodynamics
3. How trustworthy can we be? Uncertainty quantification, defective data sets and data assimilation.
4. “Plug’n’play” tools: (semi-)automatic workflows in clinical trials.
5. Fluid-Structure Interaction in clinics: why, when and how .

For each topic, one or more worldwide experts will be invited, ranging from clinicians to mathematicians.

At the end of the minisymposium 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 minisymposium will be dedicated to speed-dating between senior and junior scholars involved in the field.

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REFERENCES

- [1] Food and Drug Administration (FDA), *Regulatory Science in FDA's 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.