Oct 16, 2025

Time: 2:30 - 4:00 PM
Location: Melcher Hall, MH Room 160

Can Computational Thermal/Fluid Modeling Provide Insights into Cardiovascular Disease Therapy?

Venkat Keshav Chivukula

Associate Professor, Division of Advanced Cardiopulmonary Therapies and Transplantation

University of Texas Health Science Center

ABSTRACT:

Increasing prevalence of cardiovascular diseases such as heart failure have led to growing dependence on medical devices such as left ventricular assist devices (LVAD) to maintain adequate circulation for a patient with a failing heart. However, flow-induced complications such as emboli formation and thrombosis can lead to devastating adverse events such as pump failure and stroke. Blood as a fluid is truly unique, comprising of red blood cells, white blood cells and platelets suspended in plasma. Thus, the diverse and complex behavior of blood as a particle-laden fluid operating under various spatio-temporal interdependencies presents a fascinating and challenging problem to analyze. It is crucial to elucidate the complex interplay between hemodynamic stimuli and patient response, especially in the setting of blood-contacting medical devices such as LVADs. Several surgical and anatomical features such as left ventricle size, shape, LVAD implantation configuration, native contractility, aortic root structure and LVAD operational parameters have a significant influence on blood flow patterns and efficacy of LVAD therapy. In this seminar, I will discuss some of the approaches we use at various scales (micro and macro) to analyze hemodynamic patterns and associated complications such as stroke risk. Specifically, I will describe our recent methodologies involving virtual surgery, surgical optimization and designing patient-specific device management strategies to optimize hemodynamic performance. Further, we will also discuss thermal modeling approaches that can be utilized to investigate organ transplantation. Finally, we will discuss some of the approaches that can be utilized in the future, such as combining machine learning with hemodynamic quantification for patient-specific hemodynamic optimization towards improving disease therapy and patient outcome.

BIOGRAPHY:

I am an Associate Professor in the division of Advanced Cardiopulmonary Therapies and Transplantation at the University of Texas Health Science Center Houston. I am currently working on virtual surgery, AI-powered hemodynamic digital twins, medical imaging, health-related signal processing and medical devices using multiscale and multiphysics computational modeling of biomechanics, blood flow and heat transfer. I have a background in Mechanical and Biomedical engineering, and my interdisciplinary work is translational and spans cardiovascular and neurovascular diseases, such as LVAD therapy, heart failure, cerebral aneurysm treatment, stroke, organ transplantation and artificial kidneys. I obtained my BE in Mechanical Engineering from the University of Mumbai, India, MS in Mechanical Engineering from the University of Arizona and PhD in Biomedical Engineering from the University of Iowa. I was a post-doctoral researcher at the Oregon Health and Science University and the University of Washington. My research has been funded by the American Heart Association (AHA), the American Society of Artificial Internal Organs (ASAIO), National Institutes of Health (NIH) and the medical device industry. I am also a recipient of an Outstanding Teaching Faculty Award at the University of North Texas, AHA Career Development Award and Faculty Excellence in Research Award at Florida Institute of Technology. I love to teach and enjoy empowering students in the fantastically intriguing (and of course, complex!) realm of interdisciplinary engineering. Additionally, I enjoy K-12 outreach by spreading the power of knowledge (especially in STEM fields) to the youth of today. Outside of research and teaching, I enjoy soccer, cars, food and spending time with my family.