CARNEGIE MELLON UNIVERSITY
BME 2023 SPRING SEMINAR SERIES

Computational growth and remodeling for engineered solutions in cardiovascular disease

PRESENTED BY

Jason Szafron
Postdoctoral Scholar
Radiology
Stanford University

SCHEDULE

Hall of Arts (HOA) 160

Thursday,
February 16, 2023
(11:00AM-12:00PM)

The vasculature is an amazing, adaptive system. In response to mechanical loading and biological stimuli, blood vessels change their morphology and composition. I develop computational frameworks that simulate growth and remodeling over time to predict these changes in response to disease. My models incorporate multiple stimuli, including mechanobiological and immunological contributions, to simulate loaded behavior of vascular tissue. I have focused my career on building frameworks to improve treatments for pediatric cardiovascular disease and understand their mechanobiological origins. The potential impact of improving pediatric patients' healthy lifespan to normal levels offers a strong incentive for the design of new and innovative therapies.

In this talk, I will discuss the utility of computational modeling to identify structure-function relationships and generate hypothesis for experimental testing. I will highlight my approach for designing tissue engineered vascular grafts for treatment of congenital heart disease using data-informed constrained mixture growth and remodeling models and surrogate management framework-based numerical optimization. I will demonstrate how our model predicted a reduced need for balloon angioplasty in stenosed grafts and identified modifications to scaffold degradation behavior that decreased the degree of stenosis.

I will then show the progression of my growth and remodeling methods to incorporate multi-scale hemodynamics with reduced order models of the pulmonary arterial tree for the simulation of disease evolution in pulmonary arterial hypertension. These multi-scale models are the first methods capable of estimating the progression of key mechanobiological cues in pulmonary arterial hypertension and their link to biological factors.

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