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Plenary: Cardiovascular models in vascular disease

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Cardiovascular models in vascular disease

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Mathematical modeling has long been used to better understand vascular physiology, two types of models are typically used, assessing how vascular dynamics change over time and providing an overview of flow and pressure distributions at a given time-point. The former models are typically formulated via a system of nonlinear ordinary (delay) differential equations, while the latter seek periodic solutions of a system of partial differential equations. For both model types, to make predictions it is essential to calibrate models to data, which typically are noisy and incomplete. Model calibration is performed using sensitivity analysis and subset selection to determine a set of influential identifiable parameters that can be estimated given the model and available data. In this talk I will present example models developed by my research group discussing how to calibrate cardiovascular models to imaging and dynamic data from patients with pulmonary hypertension, and how these analysis tools should be modified in systems where the model states undergo bifurcation. The latter will be done analyzing data from patients with postural orthostatic tachycardia for which heart rate increases and oscillates in response to a stress test. Finally, I will discuss the importance of adopting a multiscale approach to explain how disease may impact dynamics.