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Modeling the Cardiovascular Dynamics of Postural Orthostatic Tachycardia Syndrome

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Title: Modeling the Cardiovascular Dynamics of Postural Orthostatic Tachycardia Syndrome

Abstract:
Postural Orthostatic Tachycardia Syndrome (POTS) affects up to three million people in the United States alone. The syndrome is characterized by an increase of heart rate of 30 beats per minute (40 bpm in patients aged 12-19 years) upon a postural change, combined with the presence of orthostatic symptoms. Additionally, recent studies have shown that POTS patients exhibit large low frequency ~0.1 Hz heart rate and blood pressure oscillations, known as Mayer waves, upon a postural change when compared to control subjects. Other studies have hypothesized that POTS patients express autoantibodies binding to $\beta_{1,2}$ and M_2 receptors. These receptors are abundant on the sinoatrial node, while α_1 receptors are associated with smooth muscle cells. We use mathematical modeling to test if subjects expressing these antibodies experience augmented ~0.1 Hz oscillations. To do so, we develop a multiscale model using a systems level five-compartment cardiovascular model, a baroreflex control regulating heart rate, cardiac contractility, and vascular resistance in response to changes in blood pressure. Specific attention is paid to the control of heart rate achieved by adding a sinoatrial node cell model. We demonstrate that by changing receptor sensitivity we can predict ~0.1 Hz oscillations in POTS patients.