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# COMPUTATIONAL MODEL FOR PREDICTION OF HUMAN CARDIOVASCULAR RISKS ASSOCIATED WITH SPACEFLIGHT ASCENSION

**Abstract**

A computational model is developed to predict the behavior of the human cardiovascular system in the context of a spaceflight ascension. The model aims to assist the development of future cardiovascular payload experiments in the McGill Rocket Team, as well as raise concerns and deepen the study of risks associated with the application of high G-forces and strong vibrations on the human body. With this goal in mind, a strong emphasis is placed on the human heart and its main surrounding blood vessels. Departing from a nominal cardiovascular state, the extreme conditions of the ascension are then considered, and the transient solver depicts the evolution of blood flows through this cardiac organ, as well as the stresses developed in its tissues. This is primarily achieved through the use of computational fluid dynamics and finite element analysis, in tandem with the fundamental mechanisms guiding the behaviors of the cardiovascular system, such as the Frank-Starling Law or the Windkessel effect. Through the above-mentioned process portraying the ascension, key aspects of the system are thus monitored to evaluate the potential risks that a subject would be put under. Such aspects include heart rate; stroke volume; right and left ventricular end-diastolic pressures; right and left ventricular end-systolic pressures; pressure gradients across the atriums; mean arterial pressure; mitral and aortic valve regurgitations; excessive formation of turbulent blood flows; and abnormal stress formation/concentration in the epicardium, myocardium, endocardium, or blood vessels. Any considerable anomalies could here be the cause of physiological traumas in the short or long term, extending from slight feelings of dizziness to internal lesions of blood vessels and eventually total heart failure and death. With the intention of assessing the model's validity and expanding its horizons, the McGill Rocket Team's payload project is considering the development and flight of an experimental setup that would allow the model's results to be compared with the appropriate testing data.