Heart failure occurs when the heart is not capable to pump blood at a sufficient rate to meet the demands of the body. Depending on the health of the heart, doctors may recommend a heart transplant, but finding a suitable donor is often a long duration process and the patient might be at an advance condition or the patient is not adequate for a heart transplant. In such cases Ventricular assistance devices (VAD) are implemented. The purpose of a VAD is to aid the heart to pump the correct amount of blood, by doing so it relieves the load that is put on the heart while giving the patient a chance for recovery. This study focuses on observing the hemodynamic effects of implementing a left ventricular assist device (LVAD) along the aortic arch and main arteries. Thrombi creation and transportation is other subject included in the study, due to the fact that thrombi can obstruct blood flow to critical arteries, mainly carotid and vertebral. Occlusion of these can lead to a stroke with devastating effects on the neurocognitive functions and even death.

A multi-scale CFD analysis a patient specific geometry model is used as well as a lumped system which provides the correct conditions in order to simulate the whole cardiovascular system. The main goal of the study is to understand the difference in flow behavior created by the unsteady pulsatile boundary conditions. The model described in this work has a total cardiac output of 8.0 Liters/minute, this for a healthy heart. Two cardiac output splits are used to simulate heart failure conditions. The first split consists of 6 Liters/minute flowing through the LVAD cannula and 2 Liters/minute via the aortic root. The second scenario is when heart failure is critical, meaning that zero flow is being output by the left ventricle, thus a split of 8 Liter/minute through the LVAD cannula and 0 Liters/minute traveling through the aortic root. A statistical analysis for thrombi motion throughout the patient aortic arch was performed in order to quantify the influence that pulsatile flow has on the particles being tracked. Spherical particles of 2mm, 4mm and 5mm were released and accounted in the statistical analysis for each of the two split configurations. The study focuses on particles that escaped on the outlet boundaries of the upper arteries (Right Carotid, Left Carotid, and Vertebral). Results exhibit the statistical comparison of means for each particle diameter as well as for the overall probability, this analysis was performed for both steady and unsteady flow conditions.

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Approved for distribution by Alain Kassab, Committee Chair, on June 24, 2013.

The public is welcome to attend.