Nanoparticle-Mediated Drug Delivery as a Therapeutic for Aortic Aneurysms

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Aortic aneurysms have increased in the past two decades because of the aging population and the rise in the number of smokers. Aortic aneurysms affect about 2.9 million people and is the 13th leading cause of death. Aortic aneurysms are localized dilations of the aorta that exceed the normal diameter by 50 percent which is more than 3cm. Rupture of an aortic aneurysm can cause massive internal bleeding and lead to sudden death. Although surgical treatments have become increasingly sophisticated, there is a lack of efficient transport of drugs to the aorta. Therefore, in order to successfully treat this disease, a targeted system that uses microcarriers and nanoparticles may be considered a promising treatment. Microcarriers are common in many drug delivery systems and offer many advantages due to their functional abilities and their application in drug delivery systems. In the design of this drug delivery system, I used the Carreau-Yasuda and Windkessel viscosity model to visualize the shear rate of the blood viscosity, in order to make sure the aorta would be able to handle such microcarriers. Then, I used advection-diffusion equations and the shear stress rate equations in order to validate that aortic aneurysms have a low shear stress rate compared to the rest of the heart. Using the ANSYS Workbench, I developed structural aortic models depicting the areas of the aorta that best allow the nanoparticles to release the drugs in the aoritc aneurysm.