Targeted Drug Delivery for Aortic Aneurysms: Using Computational Fluid Dynamics to Optimize Drug Delivery & Treatment

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Aortic aneurysms have increased in the past two decades and affect about 2.9 million people. Although surgical treatments have become increasingly sophisticated, there is a lack of efficient transport of drugs to the aorta. Currently, there is no drug available for the treatment of aortic aneurysms. Therefore, a targeted drug delivery system using a combination of microbubbles and nanoparticles is considered a promising treatment. In this research study, I created a drug delivery system using the Carreau Yasuda model to depict the concentrations of microbubbles and nanoparticles across the aneurysm wall. Based off the CAD geometries created, a lower shear stress environment allows for greater accumulation of the nanoparticle drug to the aneurysm. Futhermore, I optimized this general drug delivery system to account for a specific type of microbubble. After running a series of analyses using the mathematical equations associated with the lift, drag, and Brownian motion force, I was able to narrow down the most efficient and effective microbubble for this drug delivery system: Definity microbubble. Lastly, I discovered a potential therapeutic that could be used in the treatment through analysis of the active ingredients in the plant Artesimia Annua and Aortic Aneurysms. Then, through the analysis of the Gene Ontology database and the Kyoto Encyclopedia of genes and genomes, I was able to perform molecular docking in order to see which of the active ingredients had the highest binding efficiencies. This allowed me to conclude that Quecertin would provide the best therapeutic effects for aortic aneurysms.

Awards Won:

Third Award of $1,000