Thesis Project Portfolio

Modeling Endothelial Barrier Properties of Diseased Cerebral Vasculature

(Technical Report)

The Effect of Access to Insurance on the Diffusion of Innovation Model

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

In my STS project, I focus on people with no or worse insurance coverage who are denied access to potentially lifesaving technologies. My technical project focuses on a device to further research for the disease Cerebral Cavernous Malformations (CCMs). Not much is known about this disease since it's fairly uncommon, difficult to diagnose, and hard to treat. Both of these projects are centered around groups of people who are overlooked in medicine and engineering. Less insured people often don't have access to medical technologies, treatments, or drugs that could be lifesaving. Little funding goes into CCM research since it is uncommon and hard to diagnose.

CCM is caused by mutations in specific genes, and is often genetically linked. KRIT-1 (or CCM-1) is one of three genes responsible for the disease, but its role in the cell signaling pathways that regulate endothelial (cells that line blood vessels) behavior and morphology (how the cell changes shape) is not well understood. By using the method of silencing RNA (siRNA) to force the cell to stop (knock down) KRIT-1 protein expression and exposing the knockdown cells to shear stress, we hoped to establish the possible role of KRIT-1 in endothelial shear stress adaptation. We did this by putting cells with and without KRIT-1 expression under fluid flow to analyze the different cell behaviors. The ultimate goal of the project was to design a 3D morphology of CCM lesions as they occur in blood vessels in a perfusable hydrogel (gel-like solid block that allows fluid to flow through it) model of the affected blood vessels that can be designed to mimic the disease in small blood vessels of the brain.

In the STS portion of my thesis, I analyze the ways in which innovative medical technologies and drugs are diffused during clinical trials and after they are on the market. I do this by focusing on people who are well insured and those who are poorly insured or uninsured to determine the direct and indirect effects of varying access to technology during these different

stages. An indirect effect that I focus on is physician skill decay, which is a phenomenon that I analyze in depth to understand how inequitable access to technology might cause some physicians to lose skill by only using a certain device. I use this case study to refine the definition of Diffusion of Innovation, specifically in the medical field, by arguing that this framework should be applied to people with insurance and those without it differently. Looking at diffusion of innovation in this way can allow us to understand where inequitable healthcare might be occurring.

By doing both of these projects at the same time, I was able to borrow ideas and resources from one to improve the other. While designing the hydrogel model of the capstone project, I reflected on the potential future implications if this device was successful in creating a model CCM, like the production of a drug that decreases the risk of the lesions forming. I did research on the clinical trial process through the Food and Drug Administration (FDA), which was helpful when understanding the different steps of clinical trials in my thesis. Doing a deep investigation for my capstone helped me understand the significance of the different parts of the clinical trial processes. Conversely, understanding how inequitable the clinical trial process can be prompted me to ask questions about how clinical trials for patients with a rare disease like CCM might occur. Furthermore, reading about the different affected groups helped me consider people who might be in an intersection of these two topics: people who are poorly insured and also have an uncommon disease. Unfortunately, these people are overlooked on both counts and are even more frequently overlooked since they might not have access to medicine, treatments, or technologies that might be able to cure them or even treat symptoms.