Thesis Portfolio

Developing an Astrocyte Signaling Model to Inform and Improve Stroke Treatment
(Technical Report)

The Effects of a Failing Network on the Racial Disparity in Stroke Incidence
(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

Rebecca Della Croce
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Department of Biomedical Engineering

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Sociotechnical Synthesis

The technical and STS research papers that compose this portfolio both aim to reduce the catastrophic results of stroke. Strokes are a devastating occurrence that typically result either in death or severe disability and need to be addressed from biomedical and social perspectives. The Capstone Project is a model of astrocytes, a key supporting cell type in the brain. This model will be useful in the efforts to better understand the progression of stroke and to develop new therapies. To understand stroke from a social perspective, the STS research paper investigates the disparity in stroke incidence between minority and non-minority groups and identifies potential reasons for this disparity. In order to effectively treat stroke, research must be cognizant of the patient population and its characteristics to ensure that new treatments will be accessible to the patients who are at the greatest risk.

The Capstone Project is a signaling network model of astrocytes that can be applied to both normal and stroke conditions in these cells. The model aims to understand the signaling that occurs within these cells during a stroke and to identify pathways that might be targeted by new treatments. Specifically, the project looks to apply this model to mitochondrial treatment of astrocytes, which would provide them with an increased energy supply. The model is then used to predict the ways in which this treatment might alter the signals that astrocytes send to the other cells in the brain. Because this type of treatment is already being tested in similar pathologies in the heart, this research could support using the same treatment in strokes. The model will also be available for other research groups to use to develop additional therapies and further the scientific community's understanding of stroke.

Currently, Black Americans and other minorities have strokes at much higher rates than white Americans. In addition, minorities also suffer worse outcomes following stroke than white patients do. Thus, it is important to understand the reasons for which this disparity occurs in order to identify avenues for addressing it.

To analyze the potential driving forces behind this problem, Actor-Network Theory (ANT) is used to perform a network analysis. This research employs ANT to establish the healthcare network that was built by the institution of healthcare. The other actors involved are patients, healthcare providers, and insurance. In analyzing the network, it is clear that healthcare looked only to distinguish patients by their insurance status, ignoring other key differences in patient populations. Specifically, the network does not acknowledge that minority patients' experiences of racism can alter their health and place them at an elevated risk for poor outcomes. Healthcare also did not consider that its history of unethical, racist actions, in addition to its continued biases, contributes to significant distrust among minority patients. As a result, minority patients interact differently with the institution and care providers than non-minorities do. In failing to acknowledge these factors, the network has failed, leaving the minority community at a high risk for several morbidities, including stroke.

Overall, this research offers an explanation for how the failures of the healthcare system have contributed to the increased rate of stroke among the minority community. It concludes that experiences of racism and discrimination increase the minority population's likelihood for risk factors such as high blood pressure, which go undiagnosed and untreated due to poor communication with doctors, distrust of the healthcare system, and little to no insurance to cover the cost of care. By understanding these interactions, efforts can begin to make strides toward addressing them and closing the disparity in stroke incidence.

Considering both the Capstone Project and the STS Research in conjunction with each other allows the full picture of stroke in the United States to be understood and addressed. The technical project offers a means to improve stroke treatments and reduce the devastation caused by stroke. The STS Research provides a framework for understanding the social factors that cause stroke and can served as a guide for reducing the likelihood of its occurrence. Both aspects of research, if used together, can improve the health of the United States population and alleviate the burden of strokes on the adult population.