

Thesis Portfolio

Therapeutic Mitochondrial Delivery to Astrocytes for Ischemic Stroke

(Technical Report)

Personal Risk Analysis of Direct-to-Consumer Genetic Testing

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

Medicine has advanced in the past 100 years in regard to diagnosing and also treating diseases such as diabetes, asthma, and bacterial infections. Diagnosing a disease early is crucial for treating medical conditions and increasing the chance of survival. Direct-to-consumer genetic testing has been made available to the public in order to illuminate patients on their risk of acquiring certain diseases such as Alzheimer's, Parkinson's, and certain types of cancers in order for them to monitor and catch the disease early. However, as studied in the STS research paper, the tests can have personal risks that the consumer are not aware of when consenting to have the services performed. Treating diseases is also vital for having a patient have a full and successful recovery. However, diseases such as Alzheimer's, Parkinson's, and Ischemic stroke either have no treatment or the treatment is incomplete as it only works to treat one aspect of the disease. My biomedical engineering capstone team is conducting a preliminary study to help develop a more complete treatment for ischemic stroke that has the potential to decrease the quantity of people who have impairments after having a stroke.

The current treatments for ischemic stroke in the United States work by dissolving the blockage that is inhibiting blood flow to the rest of the brain. This current treatment, however, only treats one component of the ischemic stroke because the mitochondria also become dysfunctional leading to astrocyte and neuronal cell death. This is one of the main reasons why stroke is the leading cause of physical and intellectual disability in the United States. My capstone team is, therefore, working to test different types of mitochondria from different tissues (cardiac, skeletal, and fat) in order to determine which type of mitochondria increase ATP production and up taken at the greatest quantity in astrocyte cells. In order to evaluate the different types of mitochondria, cardiac, skeletal, and fat tissue are harvested from mice.

Peridroplet and cytoplasmic mitochondria are then isolated from fat tissue, cardiac mitochondria from cardiac tissue, and skeletal mitochondria from skeletal tissue. These mitochondria are then put in a petri dish with astrocyte cells to be endocytosed. The uptake and ATP are recorded for the endocytosed mitochondria. Analysis is performed in order to determine which mitochondria should be used as a treatment or what optimum characteristics do the different types of mitochondria have that must be considered when making synthetic mitochondria.

For the STS research paper, the personal risks of direct-to-consumer genetic testing consumers is evaluated. Direct-to-consumer genetic testing has increased in popularity over the past ten years due to the advancements in the information they are able to provide and also due to the decreasing cost. However, the results that consumers acquire from these services can be confusing because the consumers do not always understand the information they are receiving, nor the limitation that exists with these testing services. Therefore, a thorough analysis of the personal risks a person takes when performing these services is needed. In order to perform the analysis, Risk Analysis by Ulrich Beck is utilized. The expected outcomes of this paper are that many 'new risks' will be discovered that affect a large population of the United States. Additionally, realization will be made that these tests contain a greater amount of uncertainties and less stringent regulations on sharing of information than consumers are aware of. The analysis is, therefore, vital in being able to help inform the public about these tests and also help to guide future policies in order to limit unforeseen consequences of direct-to-consumer genetic testing. This work is also significant to the field of STS because it provides an analysis of how the technology and the science of direct-to-consumer genetic testing has the ability to affect the way our society is organized and the way people view their genetic information.

By working on my Capstone and STS paper together, I have been able to gain further insight on the entire process of diagnosing and also treating diseases. It has allowed me to understand the implications of a direct-to-consumer genetic testing service providing disease risk potential on a disease that does not have a treatment, including the effect that it could have on a person and their family. Additionally, by analyzing the preliminary data of a treatment for ischemic stroke, while also conducting an analysis on direct-to-consumer genetic testing, I am able to understand how important it is for a patient to understand the disease, their risk of getting it, and also what their potential survival is for the disease. Thus, by working on both of these topics together, I am able to understand the importance of diagnosing early and also in having a treatment that targets the effects of the entire disease. Additionally, I am able to comprehend how important it is, as engineers, to understand the effects a technology will have on society, while designing that technology, in order to ensure that the technology is beneficial for the society as a whole.