Thesis Project Portfolio

Utilizing DREADDs to Transiently Open the Blood Brain Barrier for Drug Delivery

(Technical Report)

An Analysis of Atypical Alzheimer's Disease Treatment Methods Using Virtue Ethics

(STS Research Report)

An Undergraduate Thesis

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Sociotechnical Synthesis

The Ethics of Atypical Alzheimer's Disease Treatments

I have always been fascinated by the intricacies of the brain's inner workings. Specifically, the complex network of neurons and supporting cells that must work together in harmony to allow an organism to perform even the simplest of tasks. A high school paper piqued my interest in neurodegenerative diseases and what can be done to mitigate their devastating effects. Alzheimer's disease (AD) has always been a standout disease for me, partially because its exact cause is still unknown despite millions of dollars being poured into research efforts annually. My technical project looked at improving drug access to the brain to treat neurological disorders. My STS project melded my interest in AD with the therapeutic platform my capstone project was based around- I focused on looking at non-standard AD treatments through the framework of virtue ethics.

My technical project is focused on using designer receptors exclusively activated by designer drugs (DREADDs) to temporarily open the blood-brain barrier to better allow drugs to access brain tissue. DREADDs are comprised of two parts: a genetically engineered receptor and a special molecule that can activate that receptor. DREADDs are currently only used by neuroscientists to study patterns of neuronal firing. My group and I wanted to repurpose it. Our plan was to use a specific DREADD in endothelial cells, the cells that line the blood vessels of the blood-brain barrier. We wanted this DREADD, when activated, to make temporary holes in this blood vessel network to allow drugs access into the brain. Through our research, we found a correlation between activation level of the DREADD and overall resistance of a single layer of endothelial cells (monolayer) in a petri dish (*in vitro*). We saw that as the activation of the

DREADD increased, the monolayer resistance showed a consistent drop. If this technology could be further developed, it could be used to transiently open the blood brain barrier and allow for easier drug access, a task that is currently hard to accomplish.

My STS project used virtue ethics to look at two atypical potential treatment methods for AD- nonpharmacological treatments (NPTs) and my capstone project. NPTs can include activities like gardening and exercise- while these are day-to-day activities for many people, they become exponentially harder for people with AD. Typically, deontology and utilitarianism are the most common ethical frameworks employed in the field of healthcare, but I believe neither one provides a comprehensive way to approach AD care, especially in a time where there are treatment methods besides simply pharmaceuticals. In my project, I explained why I believe virtue ethics is a more open-minded, context-dependent way to view AD treatment, especially opposed to action-based moral theories like deontology and utilitarianism. I hope that analyzing these treatment methods through virtue ethics can one day provide AD patients and family members with insight into which treatment route is best for their individual circumstances.

Originally, my STS prospectus focused on looking at how individualistic and collectivistic cultural elements in the United States and China affected each country's rate of AD. While I still see the value in analyzing how these elements contribute to AD, I am grateful that I was able to pivot my topic to examine the ethical ramifications of my technical project. Considering the ethics of my capstone project allowed me to see how while some people might be fully on board with this novel therapeutic platform, there are others who might have perfectly valid hesitations regarding the genetic modification aspect of my project (or potentially detrimental immune response). Overall, viewing my project (and another nonstandard AD

treatment) through virtue ethics has shown me what principles I hope to embody in my career as an engineer. I hope to always remain cognizant of the impact my work will have on people, and I want that impact to inform the nature of my work.