Why Do You Get the Cold in the Winter? Developing a Temperature-Dependent Kinetic Model for Human Rhinovirus Infection.
(Technical Report)

Moral Responsibility for the Thalidomide Birth Defects Disaster: An Actor Network Analysis
(STS Research Paper)

An Undergraduate Thesis Portfolio

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A Socio-Technical Synthesis of Medical Research

My technical project and STS research project are linked by the theme of biomedical research practices and methods for medical discovery. This includes the concept of how medical research should be conducted, both from a technical and ethical viewpoint. These two projects differ in that one offers tools to improve medical research, while the other analyzes morality and ethics within medical research. While my two works approach medical research from different vantages, both aim to analyze and address the characteristics of high-quality research.

My technical project focuses on developing a model of rhinovirus infection to study the virus' unique temperature dependent behavior. Rhinovirus causes the common cold and has been shown to propagate more efficiently at lower temperatures (Papadopoulos et al., 1999). My project adapted our group's previous model of a closely related virus to model rhinovirus instead (Lopacinski et al., 2020). This model is a complete kinetic model that makes predictions about viral propagation and several intermediates throughout the viral life cycle. Further, we encoded temperature dependence throughout the entire model using kinetic and thermodynamic equations so that viral propagation could be compared at different time points. Finally, we reevaluated various assumptions made in regards to viral encapsidation within the original model and made changes to our assumptions concerning the geometry of capsid assembly. From these changes, we were able to capture the temperature dependence of rhinovirus that has been observed in the literature. These changes show that the assumptions made concerning capsid assembly geometry are critical to reveal temperature dependence in our model. This model is a tool for understanding the mechanism behind rhinoviral temperature dependence, and will facilitate future research into the virus.

My STS research project also delves into the theme of medical research, however this time with a focus on moral responsibility within research. My research focuses on the

pharmaceutical tragedy associated with the poor testing and regulation of the drug thalidomide in the early 1960s. I use actor network theory to analyze the relevant actors within the thalidomide network. This analysis shows which actors failed within their roles, and then uses criteria for moral responsibility set out by Ibo van de Poel and Lambér Royakkers (2011). I use these criteria to determine which of these actors bears moral responsibility for the thalidomide tragedy. I conclude that Grünenthal, the parent company of thalidomide, and medical regulatory bodies bear moral responsibility, while consumers do not. The aim of my research and analysis was to understand what moral obligations different actors may have within medical research networks.

By working on these two projects simultaneously I was able to obtain a deeper understanding of each individual project. My work on my computational modeling project gave me the expertise to understand the technical papers I reference in my STS research project. My technical project also gave me a basic understanding of what standard practices and reasonable testing may look like. Further, analyzing the moral obligations of medical researchers helped me consider the moral obligations I had to my technical project. This augmented my motivation to perform thorough and careful research by highlighting the moral obligation I had to the future users of my model. My work on both these projects has helped me learn both to create technical tools to improve medical research and to consider the ethical and moral angles that every research project contains.

References

Lopacinski, A. B., Sweatt, A. J., Smolko, C. M., Gray-Gaillard, E., Borgman, C. A., Shah, M., & Janes, K. A. (2020). Modeling the complete kinetics of coxsackievirus B3 reveals human determinants of host-cell feedback. *BioRxiv*, 2020.07.26.222174. https://doi.org/10.1101/2020.07.26.222174

Papadopoulos, N. G., Sanderson, G., Hunter, J., & Johnston, S. L. (1999). Rhinoviruses replicate effectively at lower airway temperatures. *Journal of Medical Virology*, *58*(1), 100–104. https://doi.org/10.1002/(SICI)1096-9071(199905)58:1<100::AID-JMV16>3.0.CO;2-D

van de Poel, I., Royakkers, L., (2011). The distribution of responsibility in engineering. Ethics, Technology, and Engineering: An introduction. Chichester: Wiley-Blackwell.

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