Thesis Project Portfolio

Novel Bilirubin Quantification Method: Computational and *In Vitro* Validation
(Technical Report)

Using Technological Politics to Examine Racial Healthcare Disparities in Neonatal Jaundice Assessment
(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

William Adu-Jamfi

Spring, 2024

Department of Biomedical Engineering

Table of Contents

Sociotechnical Synthesis

Both my technical and STS projects focus on neonatal jaundice and the challenges posed by non-invasive transcutaneous bilirubinometry (TcB), particularly for neonates with darker skin tones. The substantial overlap in absorption spectra between bilirubin and melanin can lead to TcB overestimation, resulting in unnecessary phototherapy prescriptions with adverse effects that disproportionately affect darker-skinned neonates. My technical and STS projects allow me to comprehensively evaluate this issue from both a technical and sociotechnical perspective. While my technical project focuses on developing a proof-of-concept for a skin-tone inclusive, non-invasive TcB device, my STS research paper investigates the implicit biases within existing TcB technologies that exacerbate racial healthcare disparities.

In my technical project, I built upon the proof-of-concept developed by last year's Capstone team, which demonstrated the reliable measurement of initial bilirubin concentration through the photoconversion of bilirubin in a simplified system. My project comprises two crucial components: a computational model replicating the *in vitro* experimental setup to determine bilirubin concentrations using its photoconversion property in a more physiologically complex system, and an *in vitro* model employing a flow dialysis membrane to simulate the movement of bilirubin from tissue into the bloodstream. Through the integration of these models, my Capstone group achieved more accurate predictions of bilirubin levels in the skin and deepened our understanding of bilirubin transport mechanisms within the body.

Meanwhile, my STS research paper delves into the racial bias inherent in current approaches to obtaining accurate TcB measurements for neonates with jaundice. I argue that TcB devices unintentionally privilege neonates with lighter skin tones while marginalizing those with darker skin tones due to implicit bias in design choices. The resulting overestimation of serum bilirubin levels by TcB devices for darker-skinned neonates increases the likelihood of unnecessary phototherapy, leading to adverse short and long-term effects. Using the framework of Technological Politics, I demonstrate how design choices in TcB devices shape power dynamics and reinforce racial healthcare disparities. Through empirical evidence analysis, I emphasize the importance of recognizing and rectifying these biases to ensure equitable healthcare access for all neonates. This analysis prompts a reevaluation of TcB device design and application, advocating for inclusivity and diversity in medical technology development to address the needs of all racial and ethnic groups.

The interdisciplinary nature of my work allowed me to gain a deeper understanding of the complex issues surrounding neonatal jaundice and TcB measurements from both technical and sociotechnical perspectives. My technical project gave me insights that not only contributed to TcB device innovation but also served as a foundation for understanding the limitations and biases in current TcB technology, which were further explored in my STS research paper. By uncovering implicit biases in TcB device design and highlighting how they perpetuate racial healthcare disparities, my STS project provided essential context for understanding the social dimensions of my technical work. Working on both projects simultaneously enabled me to approach neonatal jaundice and TcB technology from multiple perspectives, bridging technical innovation with social equity and emphasizing the necessity of holistic approaches to healthcare innovation.