Every year in the United States over 300,00 critically-ill infants require specialized care at birth. Many of which face life-threatening challenges, including respiratory distress, congenital complications, and most often, prematurity. Due to these conditions, rapid medical care and intervention is needed in order to sustain the early life of these neonates. In addition, these care practices must be executed with medical competence and be ethically appropriate. This field of healthcare, known as neonatal intensive care, has pushed the boundaries of pediatric medicine and heavily incorporates technological innovation. Some of the great accomplishments of biomedical interventions consist of mechanical ventilation, surfactant therapy and incubator technology. However, despite advancements in the field of neonatology, there are still gaps in the technological and ethical nature of this space in healthcare. In particular, and for the scope of my technical project, the accuracy and efficacy of real-time diagnostics for determining neonatal heart rate after delivery is limited in regard to assessing the need for post-birth resuscitation. Therefore, when considering the evolution of neonatology, it is important to emphasize the significance of the bioethical frameworks, especially when considering technological care practices. Thus, a critical question emerges: how can biomedical innovation be integrated to ensure effective, equitable, and ethical care to the most vulnerable of patients?

This thesis portfolio will explore the technical research of neonatal heart rate monitoring systems with an emphasis on the sociotechnical and ethical analysis of bioethics in neonatal care. As such, the technical component focuses on the design and development of a wireless heart rate device specially built for premature infants. Currently, methods such as electrocardiogram and pulse oximetry technology are the standard of care, yet they are limited due to signal detection delays, vulnerabilities for inaccuracy, and a reliance manual interpretation which may lead to

human error. To solve these problems, there is a need for a novel wireless heart rate device that can use visual cues to provide immediate alerts, minimize the availability for error, and use biomaterials suited for the delicate skin of neonates. This device aims to be used in the delivery room where it will enhance the precision of care-delivery during the first critical moments after birth. This project is inspired by modern efforts, predominantly championed by the Neonatal Resuscitation Program and the American Heart Association to reduce this gap in neonatal care. Current research shares that ECG technology on average can take up to 28-seconds to achieve a signal and pulse oximeters averages over a minute for accurate readings. Thus, creating a device that solves these delays and other problems faced by healthcare practitioners aspires to lower the neonatal mortality rate, improve medical outcomes, and overall save premature infants.

The sociotechnical portion of this portfolio investigates a complementary issue inherent to neonatal care; that is, the ethical structure guiding the usage of neonatal biomedical technologies by healthcare professionals. Through a rigorous content analysis of the most-compiled bioethics doctrine, the American Medical Association Code of Medical Ethics, reveals a critical underrepresentation of guidance regulations of biomedical technology. Only 11.5% of the Code's ethical "Opinions" directly mention technology, and with only two Opinions addressing innovative medical practices. Understanding the historical background of neonatal medicine is imperative to the discussion of modern ethical practices, especially when it comes to the integration of technology into medical care. In addition, evaluating case studies of previous instances of ethical malpractice provides greater insight into the framework of neonatal bioethics – the four principles of bioethics being autonomy, beneficence, nonmaleficence, and justice. In summation, there is a great opportunity to establish specialty-specific guidelines, provide

regulations on the usage of artificial intelligence systems in clinical decision-making, and improve overall standardization of ethics education across healthcare training programs in the United States. This research concludes that technological care is inherent to neonatal medicine; yet, it remains limited due to outdated or overly-general ethical guidance which leave healthcare professionals ill-prepared to navigate the complicated nature of medical care.

In summary, the technical and sociotechnical components of this thesis offer a holistic evaluation of the ethical and biomedical practices of neonatology. The development of the wireless heart rate device strategies a practical solution to a technological shortcoming in clinical practice, whereas the STS research contextualizes this work within a broader need for more rigorous ethical guidance. The future of these fields of neonatology and biomedical innovation should put strong emphasis on bioethical policy and professional education. Overall, it is advantageous to incorporate more specialty-centered ethical codes, a greater understanding of how incorporation of technological innovation impacts the standard of medical care, and lastly, the strengthening of ethics education amongst healthcare professionals across the United States.