

Wireless Heart Rate Detection Device for Neonatal Resuscitation in the Delivery Room

**Cultural Competency at a Crossroads: The Role of Government Policies in Women's
Reproductive Healthcare**

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On my honor as a University student, I have neither given nor received unauthorized aid
on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Over the course of this past century the relationship between United States (U.S.) politics and women's reproductive rights has been complex and contentious, reflecting broader struggle around bodily autonomy, gender equity and cultural competency (Brower, 2024). From the early 20th century, political decisions and ideological frameworks have both advanced and restricted women's access to reproductive healthcare and personal agency. Pivotal events in U.S. history – from legalization of birth control and abortion to the more recent restrictive laws – reveal how political frameworks shape not only women's healthcare access but also cultural narrative encompassing women's bodies and choices concerning their wellbeing. Furthermore, past and current reproductive healthcare policies frequently overlook the needs of the most vulnerable populations, including the need for culturally competent care. This gap in equitable healthcare extends beyond reproductive rights, with implications for neonatal maternal health practices which affect the youngest and most vulnerable patients.

The inadequacy of reproductive healthcare practices and policies can be witnessed through the lack of access to neonatal technologies supporting premature infants. Premature infants – infants between 25 and 36 weeks gestation (Doherty et. al., 2023) – experience unique physiological challenges, including under developed cardiovascular and respiratory systems. This means that continuous monitoring of heart rate is required from birth (Doherty et. al. 2023). In the delivery room, heart rate detection is a critical component of neonatal care. Often indicative of the health of a newly born infant (Aziz et al., 2020; Nerdrum Aagaard et al., 2023). Despite current advances in the field of wearable technology and sensors, limited research, funding, and prioritization has led to a lack of access to noninvasive heart rate detection devices specifically designed for premature infants (Zhou et al., 2024). Additionally, without policy

initiatives which prioritize the funding of such technology, the availability of these products will remain limited and care will continue to be given in an inappropriate manner.

The technical portion of this paper will be focused on creating a prototype of a heart rate detection device for neonatal resuscitation in the delivery room. My team's goal is to decrease the time it takes to assess the heart rate of newly born babies by optimizing current electrocardiograms (ECGs), which would provide quick and accurate heart rate detection. Current methods of determining heart rate include palpating the base of the umbilical cord, auscultating for heart sounds via stethoscope, pulse rate detection via pulse oximetry, and electrocardiogram (ECG) for assessing heart rate in the delivery room. Each of these devices leave room for human error leading to overestimation or underestimation of heart rate, delaying care, or resulting in unwarranted interventions (Nerdrum Aagaard et. al. 2023).

This paper aims to address systemic inequalities in U.S. healthcare systems through the analysis of U.S. policy trends and healthcare practices; the role of cultural competency in advancing equitable healthcare policy and practice will be evaluated along with the role of technological innovation for neonates. The STS portion of this paper will specifically focus on how U.S. politics have affected access to women's reproductive healthcare services. I will be drawing on current and past U.S. legislation to shed light on the need for culturally competent health care policies and workers. Additionally, I will examine how current policies disproportionately impact marginalized groups, exacerbating discrimination and limiting equitable access to reproductive healthcare for communities facing socioeconomic, racial, and geographic barriers.

Wireless Heart Rate Detection Device for Neonatal Resuscitation in the Delivery Room

The focus of this project is to design and prototype a novel heart rate detection device to be used in neonatal delivery rooms, with the goal of improving timeliness and accuracy of heart rate detection in newly born infants. Currently about 10% of all newborns require breathing assistance immediately after birth with about 1% receiving chest compressions due to persistently low heart rate after breathing assistance is offered (Aziz et. al. 2020, Kapadia et. al. 2017). Once a newborn is delivered, heart rate is assessed to determine whether breathing is adequate (Nerdrum Aagaard et.al. 2023). Rapid assessment of heart rate is critical for determining the health and the effectiveness of initial breathing patterns of the patient; the assessment of heart rate eventually serves to guide subsequent interventions, which are outlined by the Neonatal Resuscitation Program (NRP) (“*Neonatal...*”). Current heart rate detection methods include palpating the base of the umbilical cord, auscultating for heart sounds via stethoscope, pulse rate detection via pulse oximetry, and electrocardiogram (ECG) for assessing heart rate in the delivery room. Each of these devices leave room for human error leading to overestimation or underestimation of heart rate, delaying care, or resulting in unwarranted interventions. Additionally, a particular challenge is monitoring a newborn infant's heart rate during delayed cord clamping when the baby remains attached to the mother via the umbilical cord to the placenta. Many infants are born by Cesarean section, and ECG and pulse oximetry leads are not sterile and cannot be placed until after cord clamping. With increased interest in delaying cord clamping by at least 2 minutes for both preterm and full-term infants (Aziz et. al. 2020), having a wireless device that quickly and accurately assess the heart rate of an infant as small as one pound (454 grams) will be extremely useful. Our proposed device aims to address

the limitation of current products through the creation of a small, wireless device that is sterilizable and can quickly and accurately report the heart rate of newly born infants.

Aim 1: Select a Biocompatible Material

The first objective is to identify a biocompatible material that is safe and comfortable to use on delicate skin, including preterm and full term newly born infants. This device will be able to securely but gently adhere to the surface of the neonate's skin regardless of the presence of amniotic fluid. To make this device sterilizable, we will be using a mixture of stainless steel and silicones or polytetrafluoroethylene (PTFE) to house the electrical components. By choosing reusable and sterilizable materials, the device aligns with both sterility requirements outlined by our advisors and promotes sustainable practices by reducing medical waste.

Aim 2: Develop a Reliable Heart Rate Detection Algorithm and Interface

The second objective is to create a robust algorithm capable of rapidly capturing and processing heart rate data. This data will then be transmitted to a visual display which provides healthcare professionals with immediate feedback. Visual feedback will incorporate both the numerical and real-time assessment of the heart rate and color-coding – such as green for a normal heart rate (>100 bpm), yellow for a moderate heart rate ($60 \leq HR \leq 100$), or red for a heart rate less than 60 bpm. Furthermore, the system will store and organize this data on an interface supporting real-time monitoring and future analysis, which is essential for dynamic decision-making in the delivery room.

The development of a project such as the one outlined above, has the opportunity to enhance the current standard of care for neonatal resuscitation in the delivery room. This device offers a few advancements including increasing efficiency and accuracy of heart rate detection,

ensuring an appropriate fit to premature newly born infants, and creating a wireless application so as not to hinder current devices and practices.

Cultural Competency at a Crossroads: The Role of Government Policies in Women's Reproductive Healthcare

The question serving as the framework for the STS portion is as follows: How do U.S. government policies impact cultural competency in women's reproductive healthcare, and what are the social and technological systems that shape healthcare delivery in this context?

From the lens of a Science, Technology, and Society (STS) framework, cultural competency in women's healthcare reproductive healthcare is an issue which has been constructed and shaped by socio-political factors and healthcare technologies. Cultural competency, which is defined as the ability for healthcare systems to provide services that respect and meet the diverse cultural, personal, and linguistic needs of patients, is critical in reproductive healthcare (Montalman et. al. 2023). Reproductive health care encompasses a diverse range of services, including contraception, prenatal care, abortion, et cetera, which are all impacted by shifting government policies. Given the increase in politicization of women's reproductive healthcare, it is essential to examine how policies enacted by the U.S. government, at both the state and federal level, affect the ability for healthcare providers to deliver culturally competent care. Government policies can create or exacerbate inequities in healthcare access, especially for minority groups and communities who already face structural and systemic barriers in accessing care. This question is important for understanding the broader implications of policy decisions on women's health and the healthcare system's responsiveness to cultural diversity.

The significance of this question lies in its focus on healthcare equity and the need for reproductive care systems that are capable of addressing and caring for the unique needs of a diverse range of women. As Brower (2024) notes, current policies often fail to consider individuals' intersectional identities, affecting those who experience multiple forms of marginalization based on race, socioeconomic status, or disability. Furthermore, the lack of transparency and restrictive policies pertaining to healthcare services, particularly in religiously affiliated hospitals (Freedman et. al. 2018), further complicate patient-provider interactions, leaving patients unaware or unable to access the essential care they may require.

The challenges of cultural competency in reproductive healthcare extend beyond individual patient-provider relationships; it has been shaped by systemic factors like structural racism, implicit biases, and societal attitudes towards disability and gender. For example, Knight and Miller (2023) denoted that certain policies around prenatal genetic testing and abortion were found to reinforce ableist assumptions, which underscores the need for healthcare providers to respect the autonomy of the patient without perpetuating stereotypes. One of the most recent changes to U.S. abortion policy, post *Dobbs v. Jackson Women's Health Organization*, have increased health risks for women, especially those from low-income or minority backgrounds (Lantz et. al. 2023). As these policies disproportionately impact marginalized communities, they highlight a critical need for cultural competency in reproductive healthcare systems. To delve into this issue, I will incorporate the Actor-Network theory (ANT) and comparative analysis techniques. The ANT approach will allow for a thorough understanding of how various actors – in this case, policies, healthcare institutions, providers, and patients – interact with each other to direct healthcare outcomes, while the comparative analysis will compare the effects of the implementation of certain policies on marginalized groups over time.

Actor Network Theory

The purpose of a literary and case study review is to draw comparisons between hospital systems in different states with varying reproductive healthcare laws. This will provide a comprehensive analysis of the current and past state of policy impacts on cultural competency. Literary reviews like Montalmant and Ettinger's (2023) study will highlight the racial and implicit biases exacerbating maternal mortality and help inform strategies to reduce implicit biases and disparities in healthcare.

Comparative Analysis

The purpose of comparative analysis of policies is to track how policies have historically addressed or overlooked the needs of women from diverse backgrounds. Sources like the Kaiser Family Foundation (Ranji et. al. 2023) will provide data on how current abortion laws varying state-by-state have disproportionately affected women differently. The evidence collected will be examined similar to Madlock Gatison's (2016) in that it will focus on social and cultural norms, the intersection of policies, and healthcare practices, underscoring that culturally competent policies must address the complex realities women face in reproductive healthcare.

Conclusion

The technical portion aims to discuss the creation of a wireless heart rate detection device, to increase access to technology for neonatal resuscitation, while the STS analysis explores the impact U.S. policies have on cultural competence in reproductive healthcare. The STS portion is expected to reveal critical policy impacts on marginalized groups, emphasizing the need for culturally competent practices. Together these deliverables highlight the essential steps the U.S. should take to make the healthcare system more comprehensive and inclusive.

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