

Thesis Project Portfolio

Design of a Novel Umbilical Venous Catheter with Echogenic Distance Markers for Increased Placement Accuracy

(Technical Report)

Does Medicare Impact Mortality Rates: An Analysis of the Different Insurance Coverages and the Impact on Neonatal Mortality Rates

(STS Research Paper)

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Executive Summary

The technical and STS projects come together in order to showcase the reality of developing a medical device from the engineer's perspective and needing the medical device as a patient and the actual costs associated with it. Often the true cost of medical devices for patients can be covered by insurance, but how do people who have subpar insurance or no coverage at all afford life saving measures and medical devices? The combination of these two research topics delves into the impacts of insurance coverage levels and ability to pay for care which should be taken into account by medical device developers in order to ensure that their product is available to everyone no matter the cost.

The technical paper focuses on the creation of a novel umbilical venous catheter (UVC) which is normally placed in neonates after birth if they need to be admitted to the Neonatal Intensive Care Unit (NICU). A UVC can have negative side effects if placed incorrectly, and currently the only way to ensure correct placement is via X-Ray. If placed too high, the catheter tip can be seen in the heart valve and cause arrhythmias, and if placed too low the catheter tip may rest in a hepatic vein causing the medicine delivered through the catheter to damage the tissue of the liver. Through work with UVA Health's NICU, echogenic distance markers were placed on catheters in order to increase their visibility under ultrasound, known as echogenicity, and images showed that they had a higher maximum pixel intensity unit, indicating success. The echogenic markers were made up of either silver coated microspheres, or foam tape, both providing an increase in echogenicity, but the foam tape working slightly better than microspheres. The design has yet to be implemented into catheters used on actual patients, but the data we have collected sets the foundation for this idea to be picked up by a major medical device company.

The STS portion of this research highlights the inequities of neonatal care regarding insurance coverage levels. The work highlights how lack of health insurance, and even public health insurance, can lead to poorer birth outcomes, especially for babies in black families. The research also explores how despite similar birth health, whether healthy or babies born with a genetic condition, those with public or no insurance have a higher mortality rate and often receive different discharge instructions, with babies that have private insurance receiving more supplemental and preventative care. In addition, my research found that more marginalized groups of women, such as women of color, have poorer birth outcomes compared to white women because of racial stress they have endured during their lives. Through this paper, I discuss whether or not these race related outcomes should be covered by health insurance providers in their plan, or if community health initiatives should expand to reach more young women and expecting mothers so that all women can be aware of impacts to their baby, or future baby's, health.

These two papers highlight the medical device and health insurance overlap, and how this can be leveraged in order to give patients the most comprehensive care possible. In addition, it provides insight to future medical device engineers in how to make their devices accessible to all and have them be conscious of the hoops patients have to jump through in order to receive life saving care. It allows engineers to see how making devices affordable and advocating to be covered by all insurance plans can decrease disparities in mortality rates. While engineers are mainly tasked with creating the device, they also need to take agency into making sure the device reaches the most people for the greater good.