

An Assay Method for Measuring Antibody Transport Across the Placenta

**Fetal Research and the Theory of Care Ethics Contribute to a Different Understanding of
Abortion**

School of Engineering and Applied Science

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By

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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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Prospectus

General Research Problem: Fetal Research, Technological Improvements for Saving Premature Babies, and the Resulting Deeper Implications

How can research on fetuses and technological improvements for saving premature babies connect to affect views on abortion? In the U.S. today there is much debate about how a fetus should be treated. Should we treat it as a person with all the rights and protection awarded to persons who have been born, or should it be defined as something less concrete? This question has led to ample political and social conflict for the past 60 years at least (Rossi, 1988). Since the institution of Roe v. Wade up to its overturning in the Dobbs v. Jackson case, around one million abortions were conducted every year (Keeping Michigan Healthy, 2023). For my STS research I plan to approach this much debated question by linking research on fetuses, such as the research I am carrying out in my technical project design, to current technology used to save premature babies. In my technical project I am designing an assay method - a form of laboratory testing that can measure movement across a cell barrier - to test antibody transport across the placenta. An antibody is a type of protein that is a key factor in fighting off disease and foreign pathogens in the body that may cause harm. This design is intended to aid in the discovery of appropriate Tdap vaccination times for pregnant women so as to ensure their newborn is protected from disease at the time of birth. By relating the overarching goal of my technical project and other similar pregnancy and fetal research - to take necessary steps during pregnancy to ensure the child is as healthy as possible when born - to current incubators in use at hospitals in the neonatal intensive care units (NICU), I will begin my exploration into the morality of abortion. I will couple these technological aspects with the Theory of Care Ethics to lead to a comprehensive discussion on the topic. To use the Theory of Care Ethics, I will attempt to characterize the mother-fetal relationship as well as the doctor-fetal relationship as relationships of care and explore what obligations they have to one another as a result.

Technical Research Question: An Assay Method for Measuring Antibody Transport Across the Placenta

When is the optimal time of vaccination for pregnant mothers to ensure the maximum amount of antibody presence in the newborn? Newborn children are susceptible to pertussis toxin, or whooping cough, because their immune systems have not fully developed. Because of this, pregnant women are recommended to get the Tdap vaccine during each pregnancy (CDC, 2022c). But it is not clear at what point during pregnancy is the best time to get vaccinated. The CDC recommends women get the vaccine during the third trimester of pregnancy, but in-depth research in this area is limited and the possibility of premature birth is not considered in this metric (CDC, 2022b). One reason for this lack of research is that antibody movement across the placenta is a hard thing to model. The placenta is a very species-specific organ so animal testing, such as mouse models as is often used in other research, is not an effective option. Additionally, because of ethical considerations, conducting experiments on people is not a viable alternative. In vitro experimentation - experimentation outside of an organism - is also challenging because of the multilayer feature of the placenta. Nonetheless, this is the experimentation technique I plan to capitalize on in order to answer the question above.

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Two main cell types govern antibody transport. These are syncytiotrophoblasts and microvascular endothelial cells (Li, 2022). To model how these cells interact in this context, a co-culture method must be developed. For my technical research design, I will be creating this co-culture model. To do so I will culture (grow) cells on something called a Transwell insert. Transwell inserts have a thin, semipermeable membrane inside a well-like concavity. The whole insert can be placed into a standard well plate creating apical (top) and basolateral (bottom) sections that can be used to separately measure concentrations after an allotted amount of time. Transwell inserts are commonly used to measure the rate of transfer of various molecules across some cell type. I plan to modify this by using both the top and bottom of the Transwell membrane to grow the syncytiotrophoblasts and microvascular endothelial cells together. In order to optimize this model, I will experiment with different seeding densities, cell media types, and various gels to seed the cells on.

Once the optimization stage is complete, I will test the antibody movement itself. The antibody I will be interested in is called immunoglobulin G or IgG for short. After growing the cells until they each form a complete monolayer, known as reaching confluence, across their respective sides of the membrane I will put a known concentration of IgG antibodies into the apical side of the insert. At various time points throughout the experiment, I will collect the liquid in the basolateral side of the membrane and measure the concentration of IgG antibodies there in order to quantify antibody movement across the cells. This method of measuring antibody transport across the placenta will help further the research in this field. The resulting technology could be used on its own to measure antibody transport, and it can also be used to verify computational models of antibody transport as are being made in the lab I am working in. This design is just one step towards a thorough understanding of how to best protect babies and ensure health for newborns.

STS Research: Fetal Research, Technological Development, and the Theory of Care Ethics Contribute to an Understanding of the Morality of Abortion

How does considering abortion through research related to fetal development and technology used to save premature newborns influence views on abortion, and how can care ethics contribute to this understanding? Abortion is a topic that tugs on many people's hearts for many different reasons. Some people view it as an essential part of women's rights and reproductive care. Others believe that the fetus is a person and a life and must be protected as any other person would be. Some are unsure one way or another. This debate has divided many people for years, even before the Roe v. Wade decision in 1973 (Legal Information Institute, n.d.). The importance of this question can be seen in the large numbers of women who get abortions. In 2017 (one of the years with the lowest number of abortions) there were 862,320 abortions conducted in the United States (Keeping Michigan Healthy, 2023). Regardless of which side you are on, this number shows how many lives are affected by abortion every year. Through my STS research I hope to add another perspective with which to consider the abortion controversy.

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Introduction
Discuss/Link Technical and Technological
Discuss Care Ethics
Bring it Together (Technological in light of care)

As was stated in both previous sections, my technical project (in a broad sense) investigates a facet of fetal development and the steps a person can take to ensure a healthy newborn. In other words, it is intended to allow people to better care for a child even before it is born, and this intention of caring for a child before it is born is by no means limited to immunity from disease. Research is conducted on how maternal cosmetic use during pregnancy affects children, how smoking during pregnancy causes complications, and even how a mother's diets can harm fetal development (CDC, 2022a, Li, 2019, Zhu, 2018). In addition to research on fetuses, technologies used in the context of premature birth are an interesting consideration. One type of technology that is particularly interesting is the incubator used in hospital NICUs. These incubators regulate heat, oxygen levels, and humidity while protecting the vulnerable baby from excess noise and diseases that it may not be able to handle (Eithoner, n.d.). Both the fetal research and the incubator deal with pregnancy before full term in a context seldom considered. I intend to investigate these technologies and how they deal with pregnancy to see if they constitute as substantial evidence to allow a fetus's claim to life or not.

The final method I will use to explore the morality of abortion is the Theory of Care Ethics. Care ethics focuses on interpersonal relationships and the care we are obliged to give to others in those relationships. There also exists within care ethics a distinct focus on the care that is due to the vulnerable and dependent (Held, 2007, pgs. 9-15). This theory has most commonly been used in the context of feminism and feminist thinkers, but I intend to use the concepts that have been posed to discover what obligations, if any, are due to fetuses. To carry this out I will attempt to establish 'relationships of care', meaning relationships that inherently oblige care within the context of abortion. For instance, would the mother-fetal and doctor-fetal relationships be considered relationships of care? I will also explore how the patient-doctor (patient being the pregnant woman in this case) relationship plays into this debate.

The connection between these two methods – i.e., the technological and ethical – lies in the attempt to define relationships of care to the fetus. It can be seen that care is given when pregnant women take extra steps to ensure they and their expected babies are healthy during pregnancy. Care again is given when premature babies are placed in specially designed equipment to ensure their safety and survival. But when is this care a necessity, and is it objective or subjective? In the context of morality, can it be claimed that a fetus is a life, or, contrarily, can it be claimed it is not?

Conclusion

In implementing these methods, I hope to approach the divisive topic of the morality of abortion from an empathetic view. Discussing premature babies will hopefully bring attention to the gravity of the subject, along with the women themselves who are affected. Additionally, by bringing in the ethics of care, I hope to implement this investigation with the understanding that it is a loving endeavor, not a pursuit to simply prove others wrong or right. It is to show the necessity of care in topics as potentially distressing as abortion.

Through my technical research I will develop my engineering and design skills. I will learn how to grow cells in the laboratory and how to conduct experiments. This will be an

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enriching experience of trial and error as well as design innovation at every step. How can I make the co-culture as accurate as possible, and how can I do this efficiently? These two questions will help lead me while designing experiments to optimize cell growth and antibody transfer on the short time scale allotted for the Capstone project.

Combining my technical research and STS research will allow for a broader view of both. My technical design will be able to be viewed in the light of important social debate, my STS research will aid in the forming of connections between society and technology with regards to engineers who build it, and it is through this combination that I will achieve a deeper understanding of the implications of design and technology.

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