

Thesis Project Portfolio

Carbon Source and Biofilm Formation: Implications for Bacterial Vaginosis Treatment Strategies

(Technical Report)

The Impact of Infertility Insurance Coverage on Women

(STS Research Paper)

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Executive Summary

Most women will run into issues related to their reproductive health at some point in their lives, ranging from menstrual issues to cancer. Treatment options are available, but is there a need for better treatment options for different diagnoses within women's reproductive health? Specifically, bacterial vaginosis (BV) affects more women than any other vaginal infection, and recurrence rates remain high as there is not an effective treatment. BV causes uncomfortable side effects and can contribute to larger issues, such as infertility. In the United States, about 19% of women are affected by infertility. Infertility has a wide range of negative effects on women, including physical, emotional, social, and financial effects. Mechanisms that cause BV and infertility in women are widely unknown, making it difficult to treat these issues to begin with. This can be partially attributed to women being under-researched. The National Institutes of Health began funding clinical research in 1944, but it was not until 1991 that they required women to be included to receive funding. BV and infertility also cause huge financial burdens; BV costs about \$4.8 billion globally each year, and one round of in vitro fertilization costs between \$11,500 and \$28,000. This paper aims to investigate the need for better treatment options for different diagnoses within women's reproductive health.

BV is the most common vaginal infection in reproductive-aged women. It is an infection caused by the overgrowth of multiple pathogenic anaerobes in the vagina. The dominant genus associated with BV, *Gardnerella*, is capable of forming a biofilm by synthesizing extracellular polymeric substances (EPS). This biofilm protects and promotes growth of multiple species of bacteria. Despite its prevalence, this biofilm's composition is understudied, therefore, there is a lack of effective treatment. The standard treatment is antibiotics, even with the decreased antibiotic susceptibility of *Gardnerella* in this biofilm state. This project identified the primary

polysaccharide components of the *Gardnerella* biofilm and investigated how carbon sources can modulate *Gardnerella* biofilm synthesis. This information was then used to predict and test enzymes for *Gardnerella* biofilm disruption. Lectin stains showed that N-acetylglucosamine and L-fucose were not incorporated into the biofilm. Cellulase, Proteinase-K, Lipase, alpha-Amylase, and DNase-1 all significantly disrupted the biofilm. Proteinase-K disrupted the biofilm the most, so it could be incorporated into a medication to be taken along with antibiotics. This way, the biofilm would be disrupted by the enzyme and the antibiotics could treat the infection.

For infertility treatment, New Jersey is known to be one of the best states to receive treatment and Wyoming is known to be one of the worst states to receive treatment when looking at insurance coverage, number of fertility specialists, and prevalence of support groups. The goal of this project was to find out how infertility insurance coverage policies in New Jersey and Wyoming impact women differently. When answering this question, there are clear differences in some areas and similarities in others. The multiple birth rate is lower in New Jersey and the proportion of births due to assistive reproductive technology is higher in New Jersey, so these statistics are better in New Jersey compared to Wyoming; this can be attributed to the mandated insurance coverage in New Jersey as women may choose not to transfer as many embryos at once. Regardless of location, women are affected equally when looking at emotional, social, and physical effects. The financial differences are the largest because New Jersey requires that insurance covers some part of the cost of treatment. This research leads me to believe there will be pushes in other states to mandate coverage, which is a step in the right direction.

This project aimed to answer the overall question if there is a need for better treatment options for different diagnoses within women's reproductive health. It can be concluded that there is a need for better treatment because current treatments are not mechanistically effective or cost

effective. Through my technical project, enzymes that can disrupt the biofilm have been determined, and this information should be used to take another step forward. A medication using an enzyme could be made and the FDA approval process could get started. This research could also be applied to other diseases that form biofilms and have antibiotic resistance, such as cystic fibrosis. Through my sociotechnical report, it was concluded that insurance coverage does make a difference in women's lives. As new policies and research are being developed, next steps could include following the White House's Office of Personnel Management's push of providers of federal insurance to expand coverage for infertility. It would be interesting to see how other states follow the White House's progress and how it affects different states' decision making.