Thesis Project Portfolio

Development of a Microplate Accessory for Improved Bacterial Growth

(Technical Report)

The Unaddressed Role of Religious Beliefs and Emotional Damage in Violations of Informed Consent for Medical Procedures

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Jake Thomas

Spring, 2023

Department of Biomedical Engineering

Contents of Portfolio

Executive Summary

The American biotechnology market is currently valued at $1 trillion and is expected to grow to $3 trillion by 2030. Innovations in healthcare-related technologies, therapeutics, and processes have led to billions of lives being saved and many deadly diseases being cured. As biomedical knowledge improves, technologies and methodologies operated within the healthcare industry must be scrutinously evaluated to ensure maximum benefit to society as a whole. Medical practices have an average shelf life of 5.8 years, necessitating constant innovation in the biotechnology space to remain clinically relevant. Without revisions to current medical practices, insufficient and ineffective solutions will continue to be perpetuated, endangering the people they are meant to protect. Therefore, the goal of this thesis portfolio is to address two areas in which outdated practices have resulted in improper medical treatment being delivered. The first area involves the creation of biomedical products based on inaccurate bacterial growth methods and will be covered in the Technical Report. The second area surrounds the divisive ruling on emotional harm as an actionable violation of informed consent and will be analyzed in the STS Report.

Bacterial products comprise a $200 billion market and are an essential part of industries that affect people every day. To make these products, research is conducted using spectrophotometers to quantify the growth patterns of bacteria cultured in 96-well plates. This method has seen minimal improvement in over 30 years, and limitations to bacterial mixing within these plates and oxygen transfer to the bacteria have reduced its accuracy. Therefore, the technical project sought to create a 96-well plate with baffled extrusions entering each well to enhance the dispersion, oxygenation, and growth of cultured bacteria. To ensure usability in a research setting, adjustments to the baffled lid were made until no significant optical interference occurred. Finite element analysis showed the lid could withstand forces reasonably faced during

intended use. Finally, microbead tests revealed that the baffled lid significantly increased dispersion compared to a plate without a lid.

Between 40 and 50 million major surgeries are performed in the United States every year, each of which require receiving explicit informed consent from the patient. Although heralded as the cornerstone of medical ethics, issues with the implementation of informed consent have resulted in thousands of lawsuits being filed and certain groups being unaddressed and misrepresented. Specifically, the verdict of *Salandy v. Bryk* removed emotional harm to the patient as a cause of physician negligence in informed consent cases unless concurrent physical harm could have occurred. The basis for this ruling comes from a precedent set over 60 years ago. Therefore, this STS project aimed to analyze the opinions affected groups had on the outcome of *Salandy v. Bryk* to evaluate whether or not a more equitable solution could be reached based on modern ideology. The groups in favor of the current ruling include the courts, legislators, and physicians. They mainly site the fact that implementation of emotional harm laws would be impossible and overly vague, reducing the willingness of physicians to perform certain surgeries out of fear of backlash. Opposing the *Salandy v. Bryk* ruling are religious groups and civil rights activists. They see this outcome as a form of discrimination and a blatant violation of their 1st Amendment rights. Compilation of this data clearly shows that current emotional harm practices are completely neglecting the needs of several important minority groups and that a new solution must be found.

Overall, this thesis portfolio provides information that can be used to make important changes to two outdated medical practices. While the technical project was not fully completed based on the goals set at the beginning of the year, the data that has been gathered proves that the proposed solution shows promise. Future work should be done using actual bacteria to

demonstrate improved bacterial growth with the baffled lid and finding which baffle design has the best results. If this is accomplished, major improvements to bacterial products could be achieved. For the STS project, a wealth of information was available outlining the justification each relevant group had for its opinions on the *Salandy v Bryk* case. Compiling all of this data to paint a complete picture of the view of emotional harm in informed consent was very fruitful is a great start to fixing this problem. Future work to find a better compromise in this issue will need to be done, taking into account all of the stances laid out in this research paper. If the technical and STS reports are built upon in these ways, the results could benefit the medical community and society as a whole by helping to amend two outdated technologies in need of an update.