Thesis Portfolio

Evaluation of Focused Ultrasound for the Induction of Immunogenic Cell Death

(Technical Report)

Factors Influencing Patient Treatment Decisions in Breast Cancer

(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

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Spring, 2020

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Sociotechnical Synthesis

The technical portion of this thesis is connected to the STS portion through the need to develop and implement novel therapies for breast cancer. The technical report focuses on the investigation of focused ultrasound in order to enhance the efficacy of immunotherapies. This link has not yet been established clinically, so the research is both novel and of great consequence as it has the potential to improve survival outcomes of women with breast cancer. The STS report emphasizes the elements that will drive a patient's treatment decision for breast cancer. In order for any of the information gleaned from the technical report to be relevant for patients, they must ultimately choose to undergo that treatment. Thus, understanding how to shape focused ultrasound to make it a more appealing technology is of the utmost importance to translate any new information into improved patient outcomes.

Triple negative breast cancer is a particularly aggressive and metastatic form of breast cancer that is not receptive to traditional hormone therapies. This makes it a prime candidate for treatment with immunotherapies but current state of the art immunotherapies produce positive responses in only a minority of patients. Thus, new technologies are necessary to enhance these treatments. Focused ultrasound is a technology that has shown promise in the clinic as treatment of the primary tumor with focused ultrasound it can activate antigen presenting cells that elicit a robust, T-cell driven immune response. This investigation of the ability of focused ultrasound to sensitize cancer cells to the immune system suggested several major results. Mice primed with 4T1 murine triple negative breast cancer cells pre-treated with focused ultrasound *in vitro* displayed enhanced survival compared to controls primed with saline only. There was a significant increase in mouse survival for the FUS groups compared to saline controls ($p=0.0134$). However, there was no improvement in the control of the primary tumor for mice primed with focused

ultrasound-treated cells compared to the saline controls. It appeared that the improvement in survival was driven primarily by a reduction in the lung tumor metastatic burden in the mice primed with focused ultrasound-treated cells compared to saline controls.

Breast cancer is a deadly disease that will afflict 12% of American women during their lifetime and 500,000 women die annually from it (*U.S. Breast Cancer Statistics | Breastcancer.org*, n.d.). There are currently many treatments available due to the inability of any one treatment to cure all types of breast cancer. Due to the number of therapies, selecting a treatment is a complex task that patients are expected to perform. Furthermore, there are racial disparities in the success rate of breast cancer therapy, especially between African American women and White women. This paper seeks to investigate what social and technological elements influence a woman's treatment decision and how these factors may be involved in treatment success rates. The investigation is framed within the STS concept of co-production, particularly between patients and the treatment technologies available to them. Through co-production, the relationship between patients, relevant other stakeholders, and cancer therapies can help to illuminate how these cancer technologies became widespread enough to become significant common therapies. Co-production also describes how certain stakeholders may co-produce technologies that work for them but not for all groups. Several factors that appeared to influence a patient's treatment decision included the doctor-patient relationship, a patient's tolerance for certain side effects, a patient's education level, the patient's race, and the biological characteristics of the patient's cancer. With a more thorough understanding of how these characteristics relate to a patient's decision, future studies can be aimed at optimizing technologies to help a patient make the best decision for their needs.

In working on both projects together, it became apparent that in order to develop a cancer therapy that would be useful to patients, far more than simply the ability to destroy cancer had to be considered. The technology must be attractive to patients for them to select it. In order to achieve this, it should be effective in destroying cancer cells while also limiting the side effects of the treatment. This is one place in which focused ultrasound excels as it is a targeted, noninvasive therapy with limited off target effects. Furthermore, patients should be educated about their potential therapies so that they are aware of it as an option. However, the technologies developed to treat cancer should be designed to be as inclusive as possible and benefit patients of all races as equally as possible. Without studying these two projects side by side, the importance of the patient in their cancer therapy would not have been as apparent.