Thesis Project Portfolio

Peristaltic Pump to Automate Media Flow for Tissue-Engineered Muscle Repair (TEMR) Construct

(Technical Report)

Healthcare Disparities for Patients Suffering from Muscle Loss

(STS Research Paper)

An Undergraduate Thesis

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Executive Summary

Volumetric muscle loss (VML) is the massive wasting away of skeletal muscle and civilians and military personnel both pay the cost in traumatic events such as car accidents or combat wounds respectively. A possible treatment to VML is Tissue-Engineered Muscle Repair construct (TEMR) which is being developed in the Christ Lab at UVA under which I am doing my technical research. My technical research is focused on designing and implementing a perfusion mechanism into a bioreactor system that is currently being used to grow the TEMRs. The purpose of the Christ lab growing these tissue scaffolds is to eventually treat patients who suffer from muscle loss such as volumetric muscle loss. The purpose of my STS research was to explore what sociotechnical issues patients who suffer from muscle loss, whether VML or muscular atrophy, face. To do so, I interviewed both a physical therapist who treats patients with muscle loss and a military veteran who underwent extensive shoulder muscle injuries during a helicopter training program.

The immediate rationale behind our technical research is to save time and prevent contamination of TEMRs by introducing a peristaltic pump for perfusion of media. The current bioreactor design for growing TEMRs consists of 3 cassettes that oscillate back and forth to stimulate cell growth and proper orientation for the tissue fibers to align. However, precious time of the researchers is wasted due to having to manually change out the cell culture media every 48 hours while the tissue scaffolds (which take 30 days to mature) grow. Additionally, and more importantly, when the media is changed, the closed system is opened and easily subjected to contamination. If contamination is introduced during media changing, within several hours the entire contents (tissue scaffolds and media) of the bioreactor will turn orange and have to be discarded and the whole process started from scratch.

The current results of my technical research are that we have 3D printed and assembled 2 peristaltic pumps to be used for bringing new media into the bioreactor and taking old media out of the bioreactor. However, when testing the flow rates, we were not able to get the desired flow rates consistently. Hence, we are currently in the process of troubleshooting our design and trying to get a working pump to perfuse media at the desired rates. Additionally, while troubleshooting the pump design, we are in the process of learning cell culturing so that we can seed cells onto our scaffolds as soon as we get our pump working. The purpose of this is to test if the tissue scaffolds are as viable with the perfusion pump as they were with manual changes.

My STS research aimed to answer the question of "what are the primary issues that patients who suffer from muscular atrophy or VML face?" To do so, my STS research focused on analyzing the medical, functional, rehabilitation, quality of life, and treatment disparities that patients who suffer from muscle loss face. My methodology entailed using empirical evidence in an Actor-Network analytical framework.

Key takeaways from my empirical STS research with the veteran were that military pressure to grit through a program can lead to serious injuries that military personnel have to deal with for the rest of their lives. As for key takeaways from the physical therapist, I learned indepthly about the different types of barriers patients with muscular atrophy or VML face economically and socially, and how those barriers affect the quality of life of the patient.

Both the technical and sociotechnical (STS) research tie in with each other since it is helpful for biomedical engineers and healthcare personnel to understand the different sociotechnical barriers that muscle loss patients face to better create, design, and implement functional tissue recovery. By doing so, the motivation for the importance of tissue engineering skeletal muscle will be better understood from the patient's point of view.