

Thesis Portfolio

A One-Handed Knee Aspirator Medical Device to Aid in Arthrocentesis

(Technical Report)

Actors of Telemedicine Virginia: A Response to Regional Health Disparity

(STS Research Paper)

An Undergraduate Thesis

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Table of Contents

Sociotechnical Synthesis

A One-Handed Knee Aspirator Medical Device to Aid in Arthrocentesis

Actors of Telemedicine Virginia: A Response to Regional Health Disparity

Thesis Prospectus

Sociotechnical Synthesis

Introduction

Healthcare access is a poignant issue that effects many people in the U.S. and internationally. Improving access to healthcare and efficiency of procedures is a major motivation of biomedical engineering. The technical report describes a specific medical device that enforces procedural improvement. Telemedicine is also a medical technology that utilizes data and technology to improve a procedure for care. Motivation for investigating telemedicine is driven by demonstrating ways that the telemedicine is underutilized or lacking in an improvement of access, and serve as evidence to inform policy or implementation methods in other regions. The technical report is a device that improves a specific procedure and a physical example of how research informs and drives improvements in healthcare. Motivation for the technical report is to improve a medical procedure with a technology that makes the procedure more efficient. Efficiency is a component related to access of medical technology, and as efficiency increases, price decreases and access increases. Aforementioned logic introduces an oversimplification of technologic implementation and the STS research provides a complimentary background of social factors and barriers of a medical technology application.

Capstone Project

An effusion is an abnormal buildup of fluid in the body (Gerena & DeCastro, 2019). Knee effusion is a painful condition resulting from trauma, overuse, or underlying disease (Johnson, 2000). Knee aspiration, or *arthrocentesis*, is a process in which a physician aspirates synovial fluid build-up from the knee. Fluid removal not only has therapeutic benefits, but is used for diagnostic purposes; detecting infection or trauma. The current clinical protocol for arthrocentesis involves using a 60cc syringe to draw up the fluid. This process is inefficient in

that it requires one hand of the physician to hold the syringe and one to draw back the fluid. Physicians in the University of Virginia(UVA) Sports Medicine Department expressed the need for a more efficient method of aspirating synovial fluid at the knee joint that would only require one hand. The physician's other hand is needed for maneuvering the fluid in the patient, and holding the patient's knee.

This technical proposal describes a device used in conjunction with a 60cc syringe that allows the physician to stabilize the syringe and draw back fluid with only one hand. The mechanism involved a trigger that incrementally pushed back a rod with each pull. The rod was locked into the syringe plunger, and pulls back the plunger with each increment. The proposed design addressed the goal of a single-hand procedure while also increasing the speed and efficiency. In addition, physician and patient comfort increased.

STS Research

Telemedicine was introduced in Virginia's healthcare system as a means of combating the endemic regional healthcare disparity affecting citizens in Virginia's Appalachian region. Telemedicine is a technology that provides a means of connecting patients geographically separated from adequate healthcare with physicians. As a technology with significant momentum in Virginia's healthcare system, it is necessary to consider and identify underlying social factors and actors present in the implementation of telemedicine. Actor Network Theory (ANT) is utilized as a framework for investigating the actor network inherent to telemedicine, using methods of network analysis and historical case studies to demonstrate key actants and events that represent enforcement of social factors resulting from implementation of telemedicine in Virginia. Through the mapping of telemedicine's network, this research reveals insights to social factors and marginalized groups that are affected by telemedicine. As a framework that identifies

social factors inherent to telemedicine, this research serves as evidence for advising modifications in telemedicine in Virginia and other regions.

Conclusion

Application of sociotechnical framework to assess telemedicine in Virginia provided depth when working on a technical project within a specific sector of Virginia healthcare. Looking at actors involved in healthcare through case study research and formal academic writing provided a solid base and background for the intricacies of implementing a technology in healthcare. The conscientious base acquired from sociotechnical research gave me a different perspective when working on a clinical project. Researching actors in telemedicine and how barriers to medical access are enforced was a consideration I had when thinking about designing my medical device. For example, the device design gets finished, but to name a few actors such as health insurance companies, procedural training, cost, FDA approval all inhibit implementation of the device. Looking even farther, these barriers ultimately drive up cost of the device and procedure limiting the access even farther.

Medical device design is my passion and exploring different actors in medical technology applications provided me with a toolbox of considerations when thinking about a problem or design. In future endeavors throughout my career, I will practice cognizance as to social factors involved in a medical technology. Examples of possible considerations I hope to now consider include: who is most likely to operate the technology, what barriers exist, cost.

Works Cited

Gerena, L. A., & DeCastro, A. (2019). Knee Effusion. In *StatPearls*. StatPearls Publishing.
<http://www.ncbi.nlm.nih.gov/books/NBK532279/>