Thesis Project Portfolio

Optimizing Surgical Planning for Patellar Instability Pathologies using Computational Modeling

(Technical Report)

Sociotechnical Factors Influencing Unnecessary Medical Care

(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, 2022

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Table of Contents

Sociotechnical Synthesis

The COVID-19 pandemic has brought the term “medical waste” to the foreground of many conversations, and the term is often associated with single-use materials such as disposable masks, syringes, and gloves. However, current medical practices in the United States encourage more than the waste of single-use materials; it promotes unnecessary medical care. Unnecessary medical care can be loosely defined as any medical action that is not useful. To provide context to the extent of this societal issue, the current estimated amount of money wasted on excessive and/or unnecessary medical testing and treatment annually in the United States is approximately $78.2 billion. This project aimed to identify the major contributors to the continuation of unnecessary medical practices, analyze how these factors perpetuate this type of care, and design a technical solution to reduce waste associated with unnecessary medical care in orthopedics.

The STS thesis explores how both medical education and clinical diagnostic processes as well as external sociotechnical factors influence the decisions of clinicians to order tests, scans, and treatments. This discussion first focuses on how medical technology innovations such as magnetic resonance and computed tomography imagining have molded the diagnostic processes. The development of these complex medical imaging machines proved to dramatically increase the quality of care to patients due to finer resolution tests and complex treatment options However, the costs of the energy and labor associated with using this machinery are extremely expensive, emphasizing that there is a fine line between providing high-quality diagnostics and over-spending. Furthermore, the STS thesis analyzes how external sociotechnical factors such as medical malpractice concerns, performance-based incentives, personal finances for clinicians, performance-based incentives, and insurance coverage impact unnecessary medical care. Both

literature and field research supported that these factors are significantly weighed in a clinician's decision-making process to order an imagining scan or perform surgery.

The technical thesis proposes a potential solution to a prevalent example of unnecessary medical care: patellar instability pathologies. Patellar instability, a common condition among young athletes, is characterized by displacement of the patella, more commonly known as the knee cap, from its intended resting position. Surgical planning to resolve patellar instability is highly subjective because the optimal surgery varies depending on the unique anatomy of each patient. It is therefore not uncommon for patients to return to the operating room for subsequent surgery. The patient, therefore, requires two sets of radiographic imaging scans, clinical visits, and sterilized operating room equipment. From the clinical standpoint, copious expensive medical equipment is wasted and superfluous time is spent on a singular patient that could be used to benefit other patients in need. From the perspective of the patient, they must spend double the amount of money and time on a second medical procedure that could have been avoided. Thus, the technical thesis describes a patient-personalized computational model capable of simulating plausible surgeries and their associated outcomes to quantify the diagnostic process and optimize patellar instability treatment outcomes, reducing reinjury rates and wasted medical resources.