

**DUAL INJECTION SYRINGE FOR ULTRASOUND-GUIDED MUSCULOSKELETAL
INJECTIONS**

**INCREASING COVID-19 VACCINE UPTAKE IN BLACK AMERICAN
COMMUNITIES BY IMPROVING BLACK PATIENT-PHYSICIAN TRUST**

An Undergraduate Thesis Portfolio
Presented to the Faculty of the
School of Engineering and Applied Science
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Biomedical Engineering

By

Nir Isaac Diskin

May 6, 2021

SOCIOTECHNICAL SYNTHESIS

Improving experiences associated with injection-based procedures is critical for the maintenance of our personal and public health. Focusing on the individual scale of this form of therapy, the technical research aims to increase the efficiency and level of comfort accompanying these procedures for both the physician and patient. The technical topic overcomes previous procedural shortcomings through the design and development of a novel medical device. While this device addresses many negative experiences associated with injection-based procedures, it is also essential to understand why these adverse experiences arise and their consequences. The science, technology, and society (STS) research analyzes trends and perceptions associated with these treatments through the application of a framework to relevant social groups. The tightly coupled technical and STS topics propose avenues on how to improve the experiences associated with injection-based procedures as a method of improving personal and public health.

The technical project describes the ideation, iteration, and development of a medical device made to improve upon the current methods of conducting ultrasound-guided musculoskeletal injections. The procedure requires the usage of one hand to maneuver the ultrasound transducer while the other hand guides a syringe into the target joint. Most of these treatments require injection of both an anesthetic and a corticosteroid, which, with current limitations, forces the physician to have to exchange syringe lumens while the needle remains in the patient, causing both parties discomfort and increasing overall procedure time. The proposed innovation improves upon the standard syringe with an ergonomic, one-handed, double-barrel design which allows the doctor to aspirate and inject multiple injectates without needing to

inefficiently exchange syringes. Prototypes were designed using computer-aided design (CAD), 3D printed, and reiterated based on performance and feedback from the team's advisor.

12 prototypes were successfully 3D printed, with each design iterating upon the last. The final prototype consists of a conjoined double barrel body with grips, a bifurcated cap, and a lumen dial with an adjusting fin. While the final device is capable of holding multiple injectates without allowing them to mix, due to time constraints and lack of access to high resolution 3D printing, it was unable to functionally aspirate and inject without leaking. For this reason, the prototype never underwent clinical testing.

The STS project aims to understand how to combat COVID-19 vaccine hesitancy in the United States, specifically in the Black American community. While trusted physicians have a unique position in which they can directly and drastically improve COVID-19 vaccine uptake, public trust in healthcare workers has been steadily diminishing over time, making improving the patient-physician relationship a potent therapeutic target. Actor Network theory is used to develop a framework which outlines the components of trust within the patient-physician relationship and how improving it can lead to increased COVID-19 vaccine uptake in Black American communities. The framework was derived from survey meta-analyses, case studies, interviews, and works of moral philosophy relating to the concept of trust, specifically in a medical setting.

Across numerous studies, trust in physicians is found to correlate directly with increased vaccine uptake. However, the dark history of, and ongoing, medical abuse by the state has left many Black Americans with an ingrained distrust of the American healthcare system. This cynicism comes from a perceived lack of benevolence and integrity by physicians. To overcome this divide, public health officials should partner with trusted Black institutions, such as the

Black church, to improve vaccination rates in these communities. This approach will provide a platform for physicians to begin to mend their relationship with Black patients and subsequently, combat vaccine hesitancy at the community level.

The need for improved experiences with injection-based procedures is clear. Whether it is on the personal level with the double-barrel syringe, or on the global level with improved vaccine uptake, these procedures are essential to maintaining the public's health.

TABLE OF CONTENTS

SOCIOTECHNICAL SYNTHESIS

DUAL INJECTION SYRINGE FOR ULTRASOUND-GUIDED MUSCULOSKELETAL INJECTIONS

with Trent Levy, Jacob Morris, Nathanael Zegarski

Technical advisor: Shannon Barker, Department of Biomedical Engineering

INCREASING COVID-19 VACCINE UPTAKE IN BLACK AMERICAN COMMUNITIES BY IMPROVING BLACK PATIENT-PHYSICIAN TRUST

STS advisor: Catherine D. Baritaud, Department of Engineering and Society

PROSPECTUS

Technical advisor: Patricia C. Click, Department of Engineering and Society

STS advisor: Catherine D. Baritaud, Department of Engineering and Society