# Designing A Novel Double-Barreled Syringe Device for Ultrasound-Guided Musculoskeletal Injections

## Analyzing the Effects of Double-Barreled Syringe Device Technology on Drug Abuse within the United States

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# Sociotechnical Synthesis

Ultrasound-guided injections are commonly used to treat and diagnose patients with injuries to the hip, shoulder, or knee. These musculoskeletal injections often involve administration of multiple solutions (ex. local anesthetics and steroids) to targeted regions of the body. Ultrasound technology allows physicians to accurately achieve injection location and depth, as opposed to previously used “blind” injections. Despite the increased precision from imaging, injections are still notably uncomfortable for the patient and difficult for physicians to administer. Currently, a single-barreled syringe is used to perform these injections, but limitations of this design result in discomfort and administration troubles. In an effort to reduce patient discomfort and increase physician efficiency, a double-barreled syringe design could hold two solutions at once for independent injection.

This technical project developed a working double-barreled syringe device for musculoskeletal injections that will sequentially draw and inject two different fluids without experiencing fluid mixing or leakage. In order to reach this final deliverable, an iteration-based design process was used to accomplish the desired design specifications (no leakage, solution separation, operable by one hand, width, height, thickness, weight, volume, stable luer locks). The technical project was eventually able to reach most of the project goals with a few inconsistencies with leakage and stable luer locks. However, degree of solution separation, one-handed operability, and dimensional constraints were successfully achieved. The rotation mechanism used is a double-path stopcock flipper. This design involves an additional hollowed out channel inside the rod that joins the first one. These channels would be located at a right angle to each other so only 90 degrees of rotation would be required for each rod channel to align

with a channel at the flow interface. This mechanism reduced the amount of movement required to block each path for the purpose of switching between subsequent flows from the separate syringes. The project utilized the Fabrication Lab in the School of Architecture at the University of Virginia to 3-D print the designs on FormLabs Form 2 printers. Another element that has been focused on is material selection. While using the Form 2 printers it was determined that using a different kind of resin could very well be helpful thereby the team has tested prints in White V4, Clear V4, Flexible V2, and Flexible 80A V1 resins. This selection process has allowed for greater flexibility in establishing a working water-tight interface as portions with greater elasticity can be used for the design. The project achieved the best watertight rotation mechanism through a rod made of Flexible V2 and a body made of Clear V4.

The associated sociotechnical thesis explores the evolution of recreational drug use in the United States of America and its correlation with the advent of the syringe and other syringe-like innovations. This will help with analyzing the potential social ramifications that a successful double-barreled syringe design could have to society at large. A successful design from the technical portion of this project could cause negative social ramifications. These possibilities include discovering harmful combinations of drugs to be used within the syringe, or creating new drug cocktails inspired by the alternative delivery method. It is important to explore the ramifications of this new technology as it could affect the health of members of both rural and urban communities as well as indirectly affecting crime rates, economics, and drug education. Unexpected users could use this technology in numerous ways, including for recreational drug use. Injecting drug users (IDUs) pose the greatest threat themselves and other IDUs when misusing the double-barreled syringe design. This thesis overviews potential societal

ramifications a double-barreled syringe could have on communities of injecting drug user, larger ethnic and racial groups, and populations considered at the national economic level. It calls for the successful regulation of syringe sharing and syringe disposal services and how these can be changed to include double-barreled syringe devices.

This research is tackled through a combination of STS methodologies. In current literature, there is much reference to the HIV/AIDS epidemic when it comes to the association between needles and the propagation of disease. I believe this can serve as an actor-network model for correlating the use of syringes with recreational drug use. I will use a case-study approach to analyze how previous healthcare issues involving syringes and injecting drug users have occurred. I can apply this existing research in the field of medicine and public healthcare policy to draw conclusions as to the possible ramifications of a widely used double barrel syringe on drug use. Studies from other countries besides the United States have been included to add breadth to the cultural impact that this device could have worldwide. The remainder of the analysis will be done with a focus on the United States given its unique qualities as a country.