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

Department of Biomedical Engineering

Rohan Chandra

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Technical Team Members:

Michael Burns

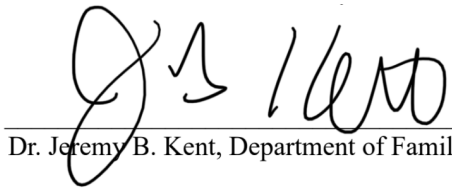
Grace Park

Teodor Calin

ADVISORS

Jeremy Kent, Department of Family Medicine

Joshua Earle, Department of Engineering and Society

Approved 

Dr. Jeremy B. Kent, Department of Family Medicine

Introduction:

The basis of my technical project is a new design for a double-barreled syringe. Clinicians would use this to quickly dispense two drugs either separately or mixed to a patient. One of the larger concerns about syringes in general is that they are actors in the larger network of drug users. Syringes can be used for healthcare but can also be used by recreational drug users. Using a syringe as a way to commit harm to oneself would be seen as an unexpected outcome to the original inventor of the syringe. However, the design of a double-barreled syringe could plausibly cause outcomes such as this.

Looking forward, I will research 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 social ramifications such as people injecting a higher volume of drugs at a faster rate to get a stronger high. Other possibilities include that people could discover combinations of drugs to be used within the syringe, or even to create new drugs inspired by the alternative delivery method. These potential abuses would have larger effects on communities. For example, in the region of Virginia where I am from, cases of heroin overdose have skyrocketed in the past decade. This has led to the extended use of Narcan and education about Narcan in my community's school systems.

Technical Project:

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. Using a single-barreled syringe, a needle is inserted into the patient with the first solution in the syringe. After injecting the first fluid the needle remains in the patient while the syringe is swapped out for a new one containing a second solution. Since the current design can contain only one fluid, multiple syringes and needles are needed for injection of disparate fluids. This creates greater discomfort for the patient due to a high number of needle insertions and excess needle movement with syringe attachment. In an effort to reduce patient discomfort and increase physician efficiency, my team and I are designing a double-barreled syringe to hold two solutions at once for independent injection. The goal of this technical project is to create a design that can functionally inject two fluids without leaking or mixing between barrels while adhering to clinical parameters set out by medical professionals.

STS Methodology:

I will tackle this research 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. The instrument in this case

would be syringes and the advent of a double-barrel syringe created in the aforesaid technical project. This innovation would act on the already complex existing network of recreational drug use which influences public healthcare policy, economics, and individual public safety. I can apply the 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. Additionally, I will attempt to contact experts on public health and medical professionals who deal directly with patients suffering from drug addiction. From these interviews and advising, I hope to gain an understanding of how those who suffer from addiction would react to an effective double-barreled drug delivery system.

Key Texts:

One study that I am analyzing is about how injecting drug users in India cope with needle and syringe use when dealing with exposure to HIV/AIDS. I hope to look at the model of syringe and needle sharing in this community and use it to analyze syringe sharing in the United States and how it could apply to a double-barreled syringe potentially being misused for recreational drug use purposes. (Chakrapani et al., 2011)

Another study I am analyzing is a report on syringe exchange programs in the United States. I hope to analyze the rehabilitation and planning services that these programs provide. With this information I will better understand and be able to design rehabilitation programs for drug users who might be using double-barreled syringes for drug use. (*Syringe Exchange Programs -- United States, 2008: Consumer Health Complete - Powered by EBSCOhost*, n.d.)

A third study I am analyzing is a case study of a peer-based syringe program in Vietnam. Although participants in this program are doing their best to safely utilize needles and syringes

for those who suffer from drug addiction, they are being persecuted by the police. Police follow people who partake in these programs and try to arrest them and sometimes even embellish or create faux reasons for arrest. I hope to understand the culture of drug use better to understand how current governments and individuals view those suffering from drug addiction. Then, I will be able to understand how a double-barreled syringe used for drug use will be combated by governments and individuals.(Ngo, 2009) I will keep in mind throughout my research that certain cultural practices will not carry over from Vietnam to the United States. Therefore, international studies will mostly be referenced for guiding the research instead of being its main proponent.

Contrastingly, there could be avenues in which the double-barreled syringe design alleviates certain problems among injecting drug users (IDUs). HIV infection is still a looming threat when IDUs do not use sterile syringes. A study based in the United States utilized mathematical modeling to estimate that an increase in access to sterile syringes could prevent costs to the U.S. in terms of future medical costs for treating newly acquired HIV infections. The analysis from the study indicates that " for each year without increased IDU access to sterile syringes in the United States, as many as 12,350 persons will become infected with HIV, leading to an estimated $1.3 billion U.S. in future medical costs for these persons" (Holtgrave et al., 1998). Thus, the surplus of sterile syringes that could alleviate HIV infection rates in IDUs could be provided with the introduction of double-barreled syringes to healthcare systems as well as pharmacies and syringe exchange programs.

References

Chakrapani, V., Newman, P. A., Shunmugam, M., & Dubrow, R. (2011). Social-structural contexts of needle and syringe sharing behaviours of HIV-positive injecting drug users in Manipur, India: A mixed methods investigation. *Harm Reduction Journal*, *8*(1), 9. https://doi.org/10.1186/1477-7517-8-9

Holtgrave, D., Pinkerton, S., Jones, S., Lurie, P., & Vlahov, D. (1998). Cost and Cost-Effectiveness of Increasing Access to Sterile Syringes and Needles as an HIV Prevention Intervention in the United States. *Journal of Acquired Immune Deficiency Syndromes & Human Retrovirology*, *18p S133-S138*.

Ngo, A. (2009, March 1). *Qualitative evaluation of a peer-based needle syringe programme in Vietnam—ClinicalKey*. https://www.clinicalkey.com/#!/content/playContent/1-s2.0-S0955395907002721?returnurl=null&referrer=null

Syringe Exchange Programs—United States, 2008: Consumer Health Complete—Powered by EBSCOhost. (n.d.). Retrieved October 4, 2021, from https://web.a.ebscohost.com/chc/detail?vid=0&sid=87306951-15f1-4c39-8095-9d6487845869%40sessionmgr4006&bdata=JnNpdGU9Y2hjLWxpdmU%3d#AN=57051824&db=cmh