Needleless Injections

Noelle Papineau, Biomedical Engineering, University of Rhode Island
BME 281 Presentation, October 24, 2018 <noellepapineau@my.uri.edu>

Abstract—Needleless injections are a great alternative to intramuscular injections using a needle. They are safer, proven to be more effective, and less painful than the existing method. Methods such as microneedle patches, ultrasound waves, and liquid jet injectors are being researched and innovated to reach their maximum effectiveness.

I. INTRODUCTION

VACCINES have been an integral part of the medical field for hundreds of years. The first vaccine was invented by Edward Jenner in 1796. He proved that infecting someone with a small amount of a virus under the skin will result in immunity to that particular virus. This method was initially used to treat smallpox, a disease that was quickly diminishing populations. [1] Today, this method is being used to prevent many more dangerous illnesses. These vaccinations are typically intramuscular, meaning that a needle administers the vaccine to a muscle. The vaccine sets off a minor immune reaction to teach the body how to fight off a pathogen. Therefore, the body will be better equipped to defend itself against the virus in the future. Because intramuscular vaccinations require complete penetration through the skin, it is often painful. Recent research in vaccinations has been focused on different injection methods. Devices have been created that eliminate the need for needles, making vaccinations even easier to administer. [2]

II. METHODS

Biomedical engineer Mark Prausnitz has been focusing his research on microneedle patches. The patches are covered in thousands of dissolvable spikes. The spikes are so short in length that they only interact with the epidermis, thus not coming into contact with blood vessels or pain receptors. [2]

Figure 1. Each spike on a microneedle patch is coated in a powder substance of the vaccine. [2]

Ultrasound waves are also being researched as a way to allow vaccines to permeate the skin with less pain than an injection by needle. Ultrasound waves make the skin temporarily more permeable, allowing drugs to easily pass through the skin. The waves cause small air bubbles to form on the outermost layer of the skin; the bubbles eventually implode and make the skin more susceptible to the vaccine. [3] Another method of needleless injections is the liquid jet injector. In this process, liquid is injected into the skin at a high enough velocity to penetrate the skin. [4]

Figure 2. The liquid jet injector is shown administering a drug onto the skin. The pressure is strong enough to reach below the skin.

III. RESULTS

Needleless injections have proven to be very effective. In some cases, these injections are even more effective than intramuscular shots. They also require less of the drug. A microneedle patch was tested on mice to protect against influenza. In this study, 90% of the vaccine dissolved within five minutes. Mice treated with the patch had longer-lasting protection against the flu virus than a group of mice treated with intramuscular injections. Engineers are attempting to create the most effective wave of frequency to use when treating the skin with ultrasound waves. Low frequency waves cause bubbles to become very unstable, causing them to burst. High frequency waves cause a larger number of number of bubbles. Therefore, using a combination of both low and high frequencies will result in maximum permeability. Treatment of pigs was ten times more successful when using two frequencies rather than only one frequency. [2]

IV. DISCUSSION

The research being done to improve vaccinations is changing the medical field in a monumental way. Not only do these vaccinations work extremely well, but they also eliminate the pain involved in vaccinations. Sore muscles are very common after an intramuscular vaccination, but needleless injections are administered into the skin rather than the muscle. Fear of needles is also very common. This is a relieving solution for many people. This technology will be extremely helpful to developing countries. The vaccines are easier to store because most of them are in the form of powders and gels that do not require refrigeration. The devices are easier to use than standard needles, so they require minimal training. Liquid jet injections are already being used to treat diabetics with insulin. In the future, researchers hope to develop vaccines and technology to prevent a wider range of illnesses. [2]
REFERENCES


