What is the most significant contribution to the medical world? While there are numerous modern pieces of technology deserving of this title, an older practice is equally suitable: vaccinations. By definition, a vaccine is the "suspension of live . . . or inactivated microorganisms . . . administered to induce immunity and prevent infectious disease" (Stern & Markel, 2005, para. 10). The idea of immunizations began developing as early as 1000 C.E., but it was not until 1796 that the first vaccination was performed. The name of the man accredited with conducting this vaccination is Edward Jenner, who was a doctor from Berkeley, England. Jenner lived in an area that experienced periodic outbreaks of smallpox, and he made an important observation from these devastating epidemics: milkmaids infected with cowpox were unaffected by smallpox. To explore his observation, Jenner devised an experiment; he took pus from the hand of a milkmaid with cowpox, and transferred it into the arm of James Phipps—an eight-year-old boy. After six weeks, when Jenner exposed James to the smallpox virus, he was unaffected by it. Thrilled with his discovery, Jenner published a volume titled *Inquiry into the Causes and Effects of the Variolae Vaccine,* which became a foundation for the future of immunology (Stern & Markel, 2005, para. 6-7). **Immunizations have positively and negatively impacted the world with disease prevention, social advances, harmful side effects, and widespread controversy.**

Hook

Background

Thesis

Before discussing the impact of immunizations, it is important to understand how they function. The purpose of vaccines is to prepare one's body for exposure to a particular infectious agent, called an antigen. To do so, immunizations introduce dead or weakened forms of a particular antigen into the body. Upon injection, lymphocytes—immune cells in the body—produce antibodies to fight the antigens. These antibodies are specific to the type of antigen, and therefore, every virus is fought with a different antibody. After one's body has destroyed each antigen introduced by a vaccine, memory cells remember how to produce the antibodies for that disease. Now, with future exposures to the real antigen, one's body will be capable of synthesizing the appropriate antibodies; in other words, it will be immune to that antigen. Contrastingly, unvaccinated people cannot create antibodies fast enough to stop the spread of an unrecognized antigen, and therefore, the disease will develop (Pappas, 2010, para. 1-5). In certain cases, a vaccine can prevent diseases closely related to its targeted disease; for example, the measles vaccination also protects against dysentery. With an insight into the complexity of immunizations, one can appreciate the positive impact they have had on the world.

Function

Initial Impact

The first positive accomplishment of vaccinations is disease prevention. Ever since they were invented, immunizations have been responsible for controlling disease and disease-caused mortalities. Based on statistics, they have excelled in this task; they prevent approximately six million deaths worldwide each year (Andre et al., 2008, para. 12). While a majority of these deaths are obviated by vaccines injected before exposure to a disease, some were ceased by vaccines injected after. For example, the rabies, hepatitis B, hepatitis A, measles, and varicella vaccines are able to provide protection after exposure to the corresponding disease. Even if a vaccine fails to fully prevent a disease, it will cause the resulting illness to be substantially

* list all names first.

The first time you cite an article that has 3 or more names, you must list them all. If you need to cite the article in the same paragraph again, you can use et al. after the first name - a nice short cut.

shorter and less severe than usual. With all of this considered, it is clear that immunizations have extended the average life expectancy. As Andre et al. (2008) stated, "elderly individuals given [an] influenza vaccine in the U.S.A. had approximately 20% less chance of suffering cardiovascular and cerebrovascular disease and 50% lower risk of mortality from all causes compared to their unvaccinated counterparts" (para. 36). Along with preventing death, immunizations are capable of abolishing diseases.

There are two levels of disease abolition: elimination and eradication. The first step is elimination; in this stage, a particular disease is terminated locally. Elimination is said to be complete when transmission of a certain disease no longer occurs between locals, and the importation of that disease does not trigger an outburst of the sickness. In four of the six World Health Organization regions, there has been excellent progress in the elimination of measles. This advancement was achieved by a two dose vaccination program that, so far, has created a population in which 95% of the people are immune. Likewise, the United States has had immense success with elimination; for example, in the pre-vaccine era, there were 21,053 cases of diphtheria per year, and now, there are none (Herper, 2013). Following elimination, the second step of disease abolition is eradication—the complete removal of a disease on a global level. Eradication is only possible if several populations around the world achieve elimination for a long period of time. Presently, smallpox has been entirely eradicated with vaccines, and it no longer exists in society. The next target for eradication is polio. Interestingly, not all members of a population need to be vaccinated in order to achieve elimination or eradication. In a scenario known as herd protection, an unvaccinated portion of society is protected by those immune to a disease. If the majority of a population is vaccinated, their immunity reduces the spread of a particular disease, and therefore, the chances of it reaching an unvaccinated individual. Notably, the percentage of a population required to be immune for herd protection to prevail varies with the type of disease. Each disease has a reproduction number—the average number of transmissions expected from a single case—and diseases with higher reproduction numbers need more immune people to achieve herd protection (Andre et al., 2008, para. 19-20).

The second positive impact of immunizations is the social advancements they have encouraged. Ranging from safer travel to protection against bioterrorism, vaccines have changed society. Firstly, vaccinations have inspired the development of health care services in countries around the world; this is largely due to the formation of the World Health Organization and the United Nations Children's Fund. Together, these two associations fund international vaccine programs. In 1974, the World Health Organization launched the Expanded Programme on Immunization, which "dramatically [increased] vaccination rates among children in developing countries" (Stern & Markel, 2005, para. 16). Secondly, vaccinations keep travellers safe while they are abroad. Before vaccines, travellers were highly susceptible to foreign diseases because their immune systems were unfamiliar with the antigens they encountered. Now, immunizations ensure travellers are immune to foreign illnesses, such as influenza and hepatitis A. Thirdly, vaccinations protect people from bioterrorist attacks. With an unsettling rise in the use of

infectious agents as weapons, vaccines ensure people are immune to potential attacks. Fourthly, immunizations indirectly influence women to birth fewer children. Since vaccines allow more children to reach adulthood, women are not pressured to have several offspring; this grants an abundance of health, educational, social, and economic benefits. Fifthly, immunizations yield long-term cost savings by preventing the need for disease treatment. In fact, the "annual return on investment in vaccination has been calculated to be in the range of 12% to 18%" (Andre et al., 2008, para. 43). In 2003, there was a global savings of over ten billion dollars due to vaccines. While immunizations generate savings, they also generate expenses; this is one of the negative impacts immunizations have had.

The first negative effect of immunizations is the health problems they cause. Ironically, "vaccine safety gets more public attention than vaccination effectiveness" (Andre et al., 2008, para. 2). After receiving a vaccination, one is likely to experience a mild allergic reaction involving swelling, redness, and a hard lump at the injection site. These side effects only last a few days, and they are treatable with basic medication or administered epinephrine. Unfortunately, more severe health problems may result from immunizations, including serious allergic reactions, fevers that lead to seizures, or sometimes death. For example, there is a one in three thousand chance that children will suffer fevers and seizures after receiving the measles/mumps/rubella vaccine. (Maron, 2015, para. 4). In response to lawsuits filed for vaccine-caused health issues, the National Childhood Vaccine Injury Act was passed in 1986; its purpose is to protect medical professionals and vaccine manufacturers from legal liabilities. Astonishingly, just under three billion dollars was spent on compensations for vaccine-caused injuries between 1989 and 2014. Along with the National Childhood Vaccine Injury Act, the Vaccination Adverse Event Reporting System was established to collect reports of vaccine-caused injuries; about 85% of the reports it receives are mild, while 15% are severe ("Background of the Issue," 2016, para. 14-16).

The reason every individual's body reacts to vaccines differently is due to four factors: genetic variations, immune deficiencies, environmental exposure, and the ingredients found in immunizations. Most vaccines contain arguably harmful components, such as thimerosal, aluminum, formaldehyde, and glutaraldehyde ("Should Any Vaccines," 2016). One of the ingredients—thimerosal—has created controversy surrounding a link between it and autism. The idea of this connection was evoked in 1998 with an article published by Andrew Wakefield; he claimed that thimerosal in the measles/mumps/rubella vaccine was a major cause of autism, but his article was retracted in 2010 due to incorrect information ("Background of the Issue," 2016, para. 17-18). Before this retraction, thimerosal was removed from a majority of vaccines in the United States to appease concerned citizens. In addition to this controversy, there have been several other disagreements regarding vaccines.

The second negative impact of immunizations is the extensive controversy they have caused. While many individuals support vaccinations, some are members of anti-vaccination groups that strongly oppose vaccines. Ever since the nineteenth century, anti-vaccination groups

have voiced their disdain for immunizations; they feel vaccines are expensive, ineffective, more harmful than helpful, and an "intrusion of [one's] privacy and bodily integrity" (Stern & Markel, 2005, para. 23). The latter point stemmed from the decision of European and North American courts to pass a law mandating the smallpox vaccine; they felt "that the need to protect the [public's] health through compulsory smallpox vaccination outweighed [an] individual's right to privacy" (Stern & Markel, 2005, para. 24). Furthermore, childhood immunizations, such as those for diphtheria, measles, mumps, and rubella, became a requirement for school attendance in the twentieth century. Due to the persistent protest of anti-vaccination groups, vaccine mandates have been revoked in California, Illinois, Indiana, Minnesota, Utah, West Virginia, and Wisconsin. In addition to anti-vaccination groups, certain religions object immunizations. For example, Catholicism and Mormonism disagree with the cultivation of vaccines in aborted fetuses; Judaism disagrees with the use of non-kosher animal products in vaccines; and Islam believes Allah—the Islamic god—created a perfect human that does not require immunizations for good health (Hamdan, 2009).

By accomplishing disease prevention, social advances, harmful side effects, and widespread controversy, immunizations have impacted the world. Deciding whether vaccinations are a positive or negative tool is left to personal opinion, but there is no denying their influence on society. As vaccines continue to develop, it is difficult to predict their future; perhaps vaccines for malaria and the human immunodeficiency virus will be invented, or maybe scientists will be able to predict next year's strain of influenza. How will immunizations continue to impact the world?

Conclusion

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References

Andre, F., Booy, R., Bock, H., Clemens, J., Datta, S., John, T., . . . Schmitt, H. (2008, February). Vaccination greatly reduces disease, disability, death and inequity worldwide. Retrieved from http://www.who.int/bulletin/volumes/86/2/07-040089/en/

Background of the Issue (2016, March 22). Retrieved from http://vaccines.procon.org/view.resource.php?resourceID=006479

Hamdan, A. (2009, December 17). Vaccines: A Religious Contention. Retrieved from http://www.vaccineriskawareness.com/Vaccines-A-Religious-Contention-

Herper, M. (2013, February 19). How Vaccines Have Changed Our World In One Graphic. Retrieved from http://www.forbes.com/sites/matthewherper/2013/02/19/a-graphic-that-drives-home-how-vaccines-have-changed-our-world/#425642ac1a6a

Maron, D. (2015, March 6). Fact or Fiction?: Vaccines Are Dangerous. Retrieved from http://www.scientificamerican.com/article/fact-or-fiction-vaccines-are-dangerous/

Pappas, S. (2010, June 1). How Do Vaccines Work? Retrieved from http://www.livescience.com/32617-how-do-vaccines-work.html

Should Any Vaccines Be Required for Children? (2016, April 4). Retrieved from http://vaccines.procon.org/

Stern, A., & Markel, H. (2005, May). The History Of Vaccines And Immunization: Familiar Patterns, New Challenges. Retrieved from http://content.healthaffairs.org/content/24/3/611.full