The Viability of Vaccination: Analyzing the Potential Benefits and Pitfalls

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Professor: L. Morrissey

Justin Wagar
8639690

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Executive Summary

The objective of this research was to analyse any potential flaws and benefits to vaccination, and to determine if the procedures is a worthwhile and safe practice.

The methodology for this report involved extensive secondary research. To maintain an objective and unbiased result, sources from multiple different backgrounds such as pro-vaccine and anti-vaccine groups were considered and analysed. This secondary research focused on analysing and gathering information online from journals pertaining to medicine and pediatrics, as well as scholarly and popular websites such as vaccines.gov and Natural News.

Four different aspects were analysed to come to a conclusion: safety of the ingredients, the effectiveness of the product, the economic effects, and society's reaction towards vaccines. As it was found, although vaccines may contain odd and seemingly dangerous chemicals such as mercury, formaldehyde and aluminum, they have no effect on humans in the quantities found in a vaccine dose. As for effectiveness, there are many studies that note that after a vaccine is licenced, there is a significant decrease in disease cases, most following a decrease of 90% to 99%. Economically, vaccines have proved to be very beneficial, respectively saving citizens and societal perspectives from over $295 billion and $1.38 trillion between 1994 and 2013 in the United States. Lastly, with respect to how the product was received by the public, there has only been a minor social backlash from misconceptions. However, immunization has ultimately been accepted worldwide and keeps the population healthy and safe from viral diseases.

In conclusion, vaccination is a beneficial, safe and inexpensive procedure. Countless tests and studies have insured vaccination's safety and effectiveness. The procedure is a significant innovation in the world of medicine that has prevented millions of deaths and illnesses. The prosperity of a population depends on its people, and keeping the population health insures it thrives economically, industrially and academically.

Introduction

Before modern medicine, the spread of disease and infections were the most potent killers on earth, causing populations to diminish and certain empires to decline. About 12,000 years ago, when humans first started forming complex communities, and discovering agriculture and animal husbandry, there came a new set of problems (Boothe 1). Confined areas were perfect for parasites and infectious diseases to spread, and the animals that accompanied these humans were spreading many of the most infectious diseases such as typhus, plague, and measles (Boothe 1).

The idea of vaccination can be dated as far back as 429 BC, when Thucydides first noticed that the people who had survived the smallpox plague in Athens would never again be reinfected by the disease ("The History of Vaccination"). Several hundred years later, in 900AD, Chinese Buddhist monks discovered that the body was able to adapt to smallpox by ingesting powdered scabs from people who were infected with the disease ("The History of Vaccination"). However, this procedure, named variolation, involved serious risk and brought upon minor illnesses. It was practiced to help prevent smallpox up until the 19th century, when British physician Dr. Edward Jenner had discovered one of the greatest public health achievements of his time: vaccination (Riedel 23).

Jenner had first heard of smallpox immunity from tales of dairymaids being immune after having suffered from cowpox. Subsequently, Jenner had thought of inoculating James Phipps, an 8-year-old boy, using matter from a dairymaid's cowpox lesions. For nine days after the procedure, Phipps was battling a mild fever and discomfort, however the next day he suddenly felt much better. One month later, Jenner inoculated the boy a second time, using smallpox lesion. Jenner declared success after no disease had developed (Riedel 24).

Jenner had discovered a fundamental concept of immunology; if the body has developed anti-bodies against a specific cell or virus, it could prevent that specific cell from getting past the immune system. Today, an inactive or modified versions of a virus in vaccines to let the body create anti-bodies to fend off any future pathogens (Riedel 21).

However, with its worldwide use and popularisation, public concerns about the safety of vaccines have been growing. The ECDC (European Centre for Disease Prevention and Control) states that "[p]arents, pregnant women, individuals with immunosuppressive disorders and other population groups targeted by vaccination sometimes express fears about the risk of side effects from vaccines (4-6), the safety of their ingredients and adjuvants (7,8), or show a lack of understanding about the risk of the diseases they prevent (9, 10)" ("Vaccine Hesitancy" 1). The decline in vaccination confidence has sparked concern amongst health organizations. To this day, they work to publish as many studies and gather as much information about the subject as possible to clarify any misconceptions.

This report will cover various aspects of vaccination such as safety and effectiveness. Further research into economic effects and society's reactions will also give a better dynamic on how vaccines might positively or negatively affect certain aspects of life. Due to a constraint on time however, this investigation primarily involves secondary research. Many studies, periodicals and news articles will be analysed to make an informed and unbiased conclusion.

Methodology

The methodology for this investigation was focused on conducting research on several important aspect of vaccination. These aspects were the safety of the ingredients, the effectiveness of the product, the economic effects and finally, society's reaction towards vaccines. Secondary research was the main method of research for this report.

This secondary research focused on analysing and gathering information online from scholarly websites and sources that pertained to one or more of the aspects listed above. All information referring to both sides of the topic were carefully analysed. For information on ingredients, governmental sources such as the CDC (Centers for Disease Control) and PHAC (Public Health Agency of Canada) were consulted. Likewise, other non-official sources such as *Natural News* and *Health Wyze* were also investigated to provide contrasting input. In addition, both peer reviewed and popular articles and journals pertaining to medicine and pediatrics were also consulted. These sources provided input on both the economic and societal effects of vaccines, as well as their effectiveness.

Correspondingly, both the results on the effectiveness and safety of vaccines were critical elements in answering the question asked in this investigation; whether vaccination is a worthwhile and safe procedure.

Analysation of the ingredients sought out to understand the effects of the ingredients used in vaccines. Objective comparisons between scientific reports and personal accounts ensured an unbiased conclusion.

For analysis on effectiveness, a similar methodology was practiced. Organization such as WAVE (World Association for Vaccine Education), demonstrated potential flaws in the documentation and testing done by the CDC, as well as other large governmental associations like the HHS (U.S Department of Health and Human Services) and PHAC. In contrast, there were many refutations against those potential flaws made by the CDC. There were many tests, surveys, and studies backing the effectiveness of vaccines. These documents were usually sponsored by verified health organizations or published in scholarly journals.

Finally, economic effects and social reception was assessed to see how much of an impact the product has on a public platform. Both peer reviewed journals and popular periodicals were analysed to broaden the scope of information about social and economic effects. However, information related to any negative economic effects was scarce. A variety of different articles, news posts and studies almost exclusively pointed towards positive economic effects. This limits the impartialness of the research in this category.

Going through each of these aspects allowed a broad examination of whether or not vaccination is a beneficial practice. Both the possible good and bad effects were taken into account to make an overall decision.

Findings and Observations

Safety and Ingredients

As with any medical procedure, safety is an important aspect that must be determined before legalising the practice. Complaints involving the use of harmful chemicals and viruses have been made against immunization by many families and specialists across the globe. In light on this however, many institutions such as the CDC have refuted against these accusations.

In general, people are concerned about the use of harmful ingredients such as aluminum hydroxide, formaldehyde and thimerosal, and how the virus itself is also contained in the vaccine. Sources such as Natural News explains that "[t]oday's vaccines not only contain live versions of the disease […], but also contain GMOs, hormones from infected cows, pigs, chickens and monkeys, untested virus combinations (like H1N1), aluminum, mercury, emulsifiers, and crossbred bacteria from animals, mosquitoes, and diseased humans" (Wells)

The Health Wyze Report also lists many dangerous ingredients in vaccines. It lists many known environmental effects of formaldehyde, an ingredient in vaccines used as a tissue fixative and preservative. The one hundred and ten effects include blindness, coma, destruction of red blood cells, and death (Corriher). Once more, in the same article, it lists many of the harmful side effects of mercury, a compound also used as a preservative. In this degree, these daunting lists have an effect on how many people may view the practice of vaccination.

However, both the FDA (Food and Drug Administration) and the CDC, confirm that in the tiny quantities found in vaccines, these ingredients possess a functional purpose that is essential to the vaccine's effectiveness. For instance, the CDC states that "formaldehyde is used to deactivate the virus contained in the vaccine as well as to dispatch of any unwanted viruses and bacteria that may contaminate the dose" ("Ingredients of Vaccines"). Subsequently, these vials have microscopic amounts of thimerosal as a preservative. The CDC explains that when each individual dose is drawn from a multi-dose vial with a new needle and syringe, there is the potential to contaminate the vial with harmful microbes. The thimerosal eliminates these microbes without effecting the vaccine itself ("Ingredients of Vaccines"). Separately, a study published in the journal *Pediatrics* had also found no harmful side effects caused by many of the most controversial ingredients: "[Q]uantities of mercury, aluminum, formaldehyde, human serum albumin, antibiotics, and yeast proteins in vaccines have not been found to be harmful in humans or experimental animals." (Offit et al. 1394).

Likewise, concerns about vaccines containing the disease itself have been addressed by a multitude of these governmental health organizations. As an example, The Government of Canada has come out to justify the purpose of these microbes in vaccines: "Vaccines are made with a tiny amount of dead or weakened germs. They help the immune system learn how to protect itself against disease. […] Through a series of steps called the immune response, the immune system learns how to recognize germs. This is so it can fight them if your child is exposed to them in the future." ("Get the Facts").

In addition, there is an extensive process that occurs before a vaccine is considered safe, and is licensed and released to the public. In an article published by the HHS (U.S Department of Health and Human Services) on *vaccines.gov* states that:

> All vaccines must be licensed (approved) by the Food and Drug Administration (FDA) before being used in the United States. A vaccine must go through extensive testing to show that it works and that it is safe before the FDA will approve it. Among these tests are clinical trials, which compare groups of people who get a vaccine with groups of people who get a "control" (e.g, either a different vaccine or placebo). A vaccine is approved only if FDA determines that it is safe and effective for its intended use. ("Vaccines are Effective")

Effectiveness of Vaccines

Depending on which source is analysed, vaccines can either be considered a phenomenal success or a placebo. This factor is greatly disputed between concerned parents and pharmacists. Complaints about the vaccines being ineffective have risen from many groups such as WAVE (World Association for Vaccine Education), one of the larger groups campaigning against vaccines. Along with this, there have been many governmental organizations that have had to come out to defend vaccines, preforming various tests, surveys, and studies around their effectiveness.

In spite of this, WAVE has published many articles denouncing the effectiveness of vaccines. Many of which point to historical references, and condemn medical authorities for misrepresenting results. WAVE explains how diseases naturally expire, and that medicine was too quick to cry victory over diseases like small pox, tetanus and polio: "History demonstrates that it was improvements in hygiene, sanitation, nutrition, standards of living, and water and food supply that lead to the decline of most infectious diseases" ("Vaccine Ineffectiveness"). There has also been scepticism around the effectiveness of the influenza vaccine. Due to its rapid mutation, the antibodies that are given through vaccination cannot protect against a newly mutated version of the virus, thus rendering the vaccine ineffective. ("Vaccine Ineffectiveness").

WAVE also explains how results from testing several vaccines such as the pertussis vaccine, should not be treated as accurate: "Described in the Federal Register, the pertussis vaccine was evaluated for potency by injection into mice, even though animal test results often to not apply to human physiology. The mice were observed for fourteen days only and 'mice dying within 72 hours after challenge [were] excluded from the test'" ("Vaccine Ineffectiveness").

However, there is lots of evidence to support the effectiveness of vaccination. Following the invention of vaccines, many of the diseases that plagued the 18th and early 19th century have been eradicated. Many diseases such as pneumococcal, rotavirus, polio and tetanus have been eradicated, most following a decrease of 90% to 99% in cases around the world. Kevin Loria from Business Insider further explains that: "Annual vaccines for kids already save up to 3 million lives a year around the globe. The pneumococcal, rotavirus, and *Haemophilus influezae* type b vaccines — just three of many — are expected to prevent 102 million illnesses and 3.7 million deaths between 2011 and 2020."(Loria)

Furthermore, the HHS, states that when analysing the history of a vaccine-preventable disease, the number of cases for it considerably drops when a vaccine is licensed ("Vaccines are Effective"). In a graph charting cases of measles per year, published by vaccines.gov (a partner of HHS), a clear and steep drop is seen after the license for the vaccine is put into place (Figure 1.1)

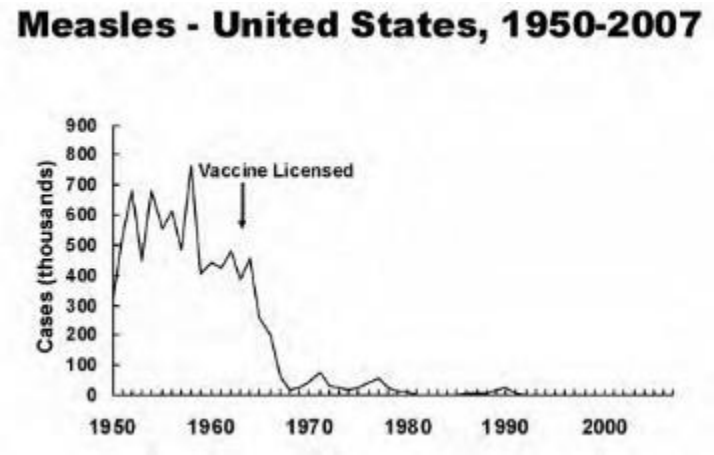

Figure 1.1 from the article "Vaccines are Effective"

The article goes on to explain that the effects of hygiene and sanitation can't possibly be the only reason behind the drop in cases of the disease:

> If the drop in disease were due to hygiene and sanitation, you would expect all diseases to start going away at about the same time. But if you were to look at the graph for polio, for example, you would see the number of cases start to drop around 1955 – the year the first polio vaccine was licensed. If you look at the graph for Hib, the number drops around 1990, for pneumococcal disease around 2000 — corresponding to the introduction of vaccines for those diseases ("Vaccines are Effective").

Economic Effects

As with any medical procedure, it is important to analyse its cost and economic effects. If a drug is too costly, or the method of production or transportation of the substance is expensive, then it can affect the overall effectiveness of the procedure or drug. For vaccines, it is important to view wide scale impacts such as economic effects due to its worldwide demand.

As a limitation of this investigation, few to no sources pointed towards negative economic effects. Although millions may be spent on the production of vaccines worldwide, the return value in terms of medical savings makes up for this cost, as will be explained in the sections below.

In an archive made by the CDC listing the prices of vaccines, the cost of one of the most common vaccines, the influenza vaccine, ranges from 7.24$ to 25.07$ per 10 doses, averaging a mere 1.62$ per dose. Other vaccines such as the one for Hepatitis A and B cost a little more than

2$ per dose. In general, the cost of a vaccines for any disease usually stays under 10$ per dose. ("CDC Vaccine Price List")

Likewise, as a result from countless studies, it has been concluded that vaccines hold an adequate benefit for most economies. Cynthia G. Whitney, MD et al. published an article in *Morbidity and Mortality Weekly Report* stating: "[A]mong children born during 1994 – 2013, vaccination will prevent an estimated 322 million illnesses, 21 million hospitalizations, and 732,000 deaths over the course of their lifetimes, at a net savings of $295 billion in direct costs and $1.38 trillion in total societal costs." (352).

Furthermore, additional evidence can be found in a study by David Bloom et al. published in the journal of *World Economics*. The study found that vaccination has many positive effects on a child's physical and cognitive development. A healthier child correlates to less absences from school, which ties into how much time they would spend learning compared to how much they would have miss if they were sick (34). Bloom also explains that:

> Healthier children leads to a better attendance in school, leading to a more thorough education and a stronger more educated employee. A study in the Philippines found that those who were vaccinated had significantly higher scores in language, math and IQ tests. This higher cognitive ability in children is predicted to be associated with higher future earnings in adulthood. (32)

Society's Reception of Vaccines

How a community receives a new medical innovation is very important to its success. If stigma is created around a procedure, then fewer people would gravitate towards it when they are in need. If no one is willing to welcome a procedure, then it ultimately affects its overall effectiveness on a population.

One of the more prominent stigmas involving vaccination is that the procedure is believed to cause autism. In 1998, former British medical researcher Andrew Wakefield published an article in the British medical journal *The Lancet*, which proclaimed that the vaccine for measles, mumps and rubella (MMR) caused autism in children. The study followed twelve children aged three to ten with a history of normal development. Following the vaccination, all twelve children had developed intestinal abnormalities such as lymphoid hyperplasia and aphthoid ulceration. In addition, eleven subjects developed behavioural disorders. There were nine cases of autism, two cases of encephalitis, and one case of disintegrative psychosis. Haemoglobin count was also low in four of the children (Wakefield 637).

These results caused a great deal of concern amongst many parents worldwide. A number of these individuals have stood up to form groups campaigning against enforced vaccination, as it infringes on either their religious or philosophical beliefs. Many refusing to vaccinate themselves or their children, and demanding that the procedure be banned. (Piper-Terry)

However, in 2010, the article was retracted from *The Lancet*, as many subsequent tests performed by many medical institutions such as the CDC, ECDC and PHAC refuted the results. The article was accused of misrepresenting data obtained and overlooking the small sample size.

Such studies with results that contrasted Wakefield's include tests performed by Luke E. Taylor et al. for the journal *Vaccine*. The results of this study found that the controlled cases matched very similarly to the subjects who were vaccinated. Five cohort studies involving 1,256,407 children, and five case-controlled studies involving 9,920 children took part in the analysis (Taylor 3623). Likewise, a study published in 2013 in *The Journal of Pediatrics* analysed data from 3 managed care organizations. 1008 children with matching birth year and sex were standardized through in-person evaluations in order to compensate for the broad categorization of ASD (autism spectrum disorder). The results found no evidence indicating an association between exposure to antibody-stimulating proteins and the risk of developing ASD or any other variant in the first two years of life. (Destafano 561)

Conclusion

Throughout this report, both potential positive and negative aspects of vaccination were analysed to determine if the procedure was in fact beneficial and safe. Research was done on four important aspects: Safety of ingredients, effectiveness, economic effects, and society's reaction towards the product.

As a result of this investigation, it was found that vaccines could potentially be harmful due to their dangerous chemical compositions. On the other hand, it is also argued that the amount of these chemicals used isn't enough to cause any harm. The key element being that it was verified governmental health organizations that were backing the safety of vaccines, compared to independent researchers backed the opposite.

As for effectiveness, there is scepticism around the effectiveness of certain vaccines that protect against rapidly mutating disease. It was also argued that decline in disease could also be due to advances in hygiene and sanitation, rather than vaccination. However, the HHS and other organizations like it have actively refuted against these claims.

When analysing economic effects, there were few to no sources stating any relevant economic downsides to vaccination. By contrast, there were many sources such as independent and organizational studies verifying several positive economic effects related to vaccines. Keeping hospitalization needs down can be a big financial benefit in countries with limited healthcare.

Finally, when researching society's reception of the procedure, it was found that there was a recent stigma involving mental disorders being linked to vaccination. An article published in 1998 in *The Lancet* had caused a social divide, getting many people to rally against vaccines or ignore any warnings from health organizations. In particular cases, parents would demand that their child be exempt from scheduled vaccination at school. However, behavioral effects have not been confirmed. Many subsequent tests performed by several organizations have been made that show no correlation between vaccination and mental disorders.

In conclusion, it was found that vaccine have an overall positive health impact. Although there is a select amount of people that refuse this verdict, there are many studies and surveys performed by verified organisations that have proven this verdicts.

With respect to its safety, the human body, even at a very young age, is unaffected by the microscopic quantities of certain ingredients such as thimerosal, formaldehyde and aluminum. All ingredients found in a vaccines have a necessary and functional purpose and have been found to be safe to use in the given dosage.

As for effectiveness, there are many studies that see significant decrease in disease cases as vaccines are licenced. Many tests have been made by several verified health organizations (CDC, PHAC, HHS) that prove the effectiveness of antibodies preventing infection.

In terms of economic benefits, the massive decrease is disease has kept millions out of hospitals, saving countless citizens from expensive medical bills. A healthier population has also shown to have an impact on a workers proficiency, which leads to a thriving industry. Its low cost also makes it available to countries around the world.

Finally, in terms of the effects on society, many people still have concerns about vaccinating their child. As long as there is a distrust between a community and their government, there will be people who refuse to take part in the practice. However, if the majority of the population is immune to disease, every virus that plagued humans in the past will soon be eradicated.

The purpose of this investigation was to see if vaccination is a beneficial and safe procedure. As a conclusion, it was found that vaccines are very effective and pose no physical or psychological danger to humans of all ages. It is an affordable procedure that can help save millions of lives and billions of dollars worldwide.

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