Last Breath: An In-Depth Analysis of the Anti-Vaccination Epidemic in Pertussis

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Abstract

Vaccines have long been a preventative mechanism against deadly diseases. However, parental distrust of vaccines is steadily rising. The complications associated with some vaccines has lead to parents fearing the effects of administering the medication [1]. Yet, parents do not understand the severity of the diseases relative to the side effects. Moreover, antivaccination parenting is based in thought processes that are inaccurate [1]. Many parents believe that vaccines can lead to afflictions such as Autism [1, 2]. Following, there is an intense occurrence in which parents are admitting that they lack trust in legislation and governing bodies [1]. Parents believe that the government is poisoning their children [1]. Besides the fears that lead to evading immunization, other parents have religious circumstances that prevent them and their children from being vaccinated [3]. Additionally, there are a select few of individuals who are unable to be protected by vaccinations such as newborns and immunocompromised citizens [4]. Antivaccination beliefs lead to a disruption of herd immunity [4]. Herd immunity is a necessity to protect the health of the majority of the population [4]. It suggests that if the population has a high rate of immunity, then there is a lesser chance that unvaccinated individuals are in contact with infected people [4]. Saying this, the decrease in vaccination has led to a decline of herd immunity in the United States.

Introduction

Diseases have plagued the human race for our entire existence. Natural remedies and ancient measure have been taken to control the rise of the disease epidemic. Through medical advancements, researchers were able to create vaccines to combat disease. A vaccine is described as a substance that stimulates the production of antibodies and provides immunity against one or more diseases. One of the most common and valuable vaccinations is the Tdap vaccine that protects infants and children against Diphtheria, Tetanus, and Pertussis. Instances of Diphtheria are most common to areas where there is an unclean water source. These areas are more than often in third world countries. It is possible for an individual to contract tetanus from being punctured with a dirty or rusty object. Pertussis is a disease that is acquired when harmful bacteria is passed through the air or through direct contact such as kisses to a newborn baby.

Pertussis, commonly known as whooping cough, is a respiratory illness caused by *Bordetella pertussis* bacteria [1]. Pertussis is a contagious disease most often spread through coughing and sneezing. Newborn infants are at the greatest risk for serious disease and death from pertussis infection.

Despite these concerns, parents are choosing not to vaccinate their children. Moreover, Political scientists and psychologists have identified values-based differences in political thought that lead to policy and belief differences [1]. For example, the Moral Foundations Theory provides a framework for understanding hidden values that may encourage individuals to lose support for vaccinations. Adding to this, public health researchers are beginning to reroute their compasses on finding the issues that are connected to vaccine hesitancy. Researchers have that the main issues parents have with vaccines are health concern, distrust in the government, and religion [1, 3].

Decreased support for vaccinations has led 48, 277 pertussis outbreaks throughout the United States. In 2012, the U.S had the highest number of reported whooping cough cases since 1955 [5]. Beginning in the 2000s, the number of pertussis cases in the United States has increased significantly [5]. The Center for Disease Control reports that there are about 10,000 to 40,000 cases of pertussis reported each year in the United States. There have also been about 20 deaths across the country.

Researchers have been working to combat these discrepancies through maternal education, advertisement, and policies. However, radical antivaccination parents continuously fight to maintain their right to not vaccinate their children. Therefore, there is a need to analyze the vulnerability of this nation's children.

Parental Position

The greatest argument against vaccinating one's child is that it infringes on parental liberties [1]. Individuals believe that the nature of their parental intuition is more powerful than the suggestions of medical [1, 6]. Thus, they believe that what they can naturally provide for their children is more beneficial than any artificial substances [6]. Moreover, some parents believe that their children should not be vaccinated because of there is a likelihood that they may contract Autism Spectrum Disorder (ASD) [1, 2]. Other countering beliefs are in relation to one's faith or religious practices [3]. Concurrently, one of the most fatal assumptions is that an individual's child does not need to be vaccinated because the children around the child have received vaccinations [4].

Vaccine refusal has been analyzed to determine the reasoning behind parents who refuse to vaccinate their children during the gestational stage. The categories that were presented were individuals who were not referred to receive vaccination, individuals who did not follow up with their primary care physician, parents who had unidentified personal reasons, parents who had invalid contraindications, parents who did not have prenatal care, parents who had valid contraindications, and individuals who had unknown reasons [3]. The results of this study are presented in Figure 2 [3]. The third highest reason for vaccine refusal was personal belief at 20% of the cases [3].

Medical Beliefs

One of the most notable beliefs that parents who disregard vaccinations hold is that the administration of a vaccine will give their child ASD. In 1999 a paper titled, "MMR Vaccination and Autism" was published in The Lancet [2] [7]. This paper was written to identify various linkages between Autism and the MMR (Measles, Mumps, and Rubella) vaccine. The publication of this article caused major public concern leading to many parents refusing to vaccinate their kids [2]. However, upon more thorough review, the article was found to be fraudulent and baseless. Since then, the article and articles relying heavily on these experiments have been debunked and retracted from all major science journals. The individuals responsible for the falsified information also had their medical licenses revoked [2]. Yet, parents continuously refuse to administer the medication.

Parental refusal has caused for more studies to be presented to broaden parental knowledge on vaccinations. In a study conducted between 2011 and 2017 it was determined that ASD was diagnosed in 1341 (1.6%) children, and the incidence rate was 3.78 per 1000-person years in the Tdap exposed and 4.05 per 1000-person years in the unexposed group (HR: 0.98, 95% confidence interval: 0.88–1.09) [2]. This presents that Tdap vaccination is not linked to Autism Spectrum Disorder [2]. Furthermore, a study that was carried out from 2011 to 2014

distributed data of children who were vaccinated and children who did not receive vaccinations. This study showed the incidence of autism between the group of children [2]. The difference between children who acquired autism and were vaccinated versus children who were not vaccinated was less than .05% [2]. Figure 3 displays this data. This displays that the TdaP vaccine does not cause Autism [2]. Thus, Becerra. Et al. supports recommendations to vaccinate pregnant women to protect infants. Yet, many pregnant women feel that it is too risky to vaccinate an unborn child [2].

Religious Liberty in the U.S. and Related Religious Liberty Exemptions

Due to initiatives to support individuals of varying religions, doctors and schools must allow individuals who present religious convictions to neglect to vaccinate their children [3]. In some religions there is a focus to let illness to be of God or a higher power's will. For example, Christianity presents that "God corrects us by sending sickness and filling our bodies with pain," Job 33:19. This is interpreted that the contraction of an illness can be seen as a means of teaching an individual or an individual's family about the repercussions of sin [3].

Furthermore, unvaccinated children and families with comparable attitudes and beliefs regarding vaccination often reside in the same geographical area. Notably, 12.3% of all children attending public schools and 18.8% attending day care in Ashland, Oregon, reported exemptions from mandatory vaccination compared with 2.4% for the state [3]. Additionally, multiple outbreaks have been reported in isolated religious communities where most parents have chosen to not vaccinate their children [3].

It is accurate that some religions express acceptance of vaccinations. Followers of the Quran believe that vaccinations are valuable because Allah will not put an illness on Earth that

for which He has not created a cure. Thus, areas with high Islamic populations usually have a high vaccination rate [3]. Countering, a diverse state that has been examined for religious exemptions is New York [3]. All states allow exemptions due to underlying medical conditions, forty-eight states allow religious exemption, and twenty states allow personal belief exemptions (PBEs) [3]. However, New York State (NYS) permits medical and religious exemptions to school immunization requirements [3].

Religious vaccination exemptions were reported through school surveys of the NYS Department of Health from 2000 through 2011 [3]. Following, they were reviewed by county official. The occurrence of exemptions was compared to incidence rates of pertussis among children who were reported to the NYS Department of Health Communicable Disease Electronic Surveillance System [3].

This system revealed that the number of pertussis incidents increased from about forty individuals per 100,000 seventy individuals per 100,000 children over the eleven years of the test [3]. Saying this, the amount of religious exemptions correlated with this trend, rising steadily across New York State from .25% in 2000 to greater than 1.0%. Also, counties that included high rates of exemption had distinguishably high rates of pertussis outbreaks [3]. These findings were similar to other areas that showed clustering pertussis outbreaks. The increase of exemptions also begs the question as to whether or not parents seek religious compliance to satisfy personal beliefs [3]. This is because the rising number of religious exemptions is unknown [3]. However, migration of religious groups, such as the Amish population, may influence incidence of pertussis [3].

Vaccination Laws

Immunization preventable disease levels are currently at a record low. The Center for Disease Control works intimately with general health offices and private companies to improve and continue vaccination inclusion and to screen vaccine safety [7]. One device used to keep up low rates of vaccine-preventable diseases is vaccination law [8]. State inoculation laws incorporate immunization necessities for children in public and private schools and childcare settings, college students, and medical providers and patients in specific offices [8]. State laws, likewise, influence access to immunization benefits by deciding if giving inoculations is provided routinely by medical professionals [8]. The Public Health Law Program allows for resources to be given to practitioners as well as provides legal counsel for vaccination laws [8].

Forward, health care professionals and volunteers are increasingly encouraged to get vaccinations in order to work in at-risk environments [8]. This places a lower likelihood that a child will receive a disease from an adult. Of course, the direr issue is that children are contracting seemingly eradicated diseases from one another [8].

All states require children to be vaccinated against certain transferable sicknesses as a condition for school participation [7]. In many cases, state school inoculation laws explicitly apply to both government funded schools and tuition-based schools with indistinguishable vaccination and exclusion arrangements [7]. Moreover, all states establish inoculation prerequisites for youths as a condition for child care attendance [8]. These prerequisites regularly reflect the necessities for public school children.

Regarding Pertussis, three states have legal provisions specific to healthcare worker pertussis vaccination, and four states have provisions pertaining to pertussis vaccination in patients [8]. In short, health care professionals in Nebraska, Indiana, and California are required to receive vaccinations in order to serve the facility [8]. The instances differ as some states require that an employee be vaccinated before he or she enters the building, while others give a certain time-frame for the employee to be vaccinated [8]. The intricacies of patient vaccination have more variation.

Nebraska identifies that each general hospital shall offer onsite vaccination to patients. These patients must receive vaccination before they are discharged. Indiana requires that all children who are seeking to be institutionalized, placed in long-term care, or rehabilitation facilities be vaccinated and present written evidence of vaccination [8]. Louisiana requires that the parents of newborns at each licensed hospital be vaccinated prior to discharge [8]. In New York, it is a requirement that hospitals offer the vaccination to the parent or guardian who intends to care for the newborn [8]. Areas where these requirements are properly implemented have a lower likelihood of pertussis outbreak.

Herd Immunity

High vaccination levels are extremely important to public safety and health. This is because immunizations are necessary to maintain Herd immunity. Herd immunity is an instance that occurs when a population contains a certain number of protected individuals [4]. These individuals could be protected through vaccination or through recovering from a disease in which they contracted [4]. Because of this, the disease is unable to spread throughout the population. Thus, creating a low probability that an infected person will come into contact with an unprotected individual [4]. Furthermore, the percentage of the population who needs to be masked from the disease to achieve herd immunity varies depending on the infectiousness of the disease, the transmission route, the vaccine's efficacy, and the degree of contact between a population's people [4]. In relation to Pertussis, disruptions in herd immunity causes for the Anticipated Risk (AR) of the general population as well as children 0-2 years-old to increase

(See Figure 1). The addition of the vaccine displays lower levels of infection. Moreover, the risk of vaccinated children receiving the disease is much lower. Group resistance is critical to ensure people who cannot be immunized or the individuals who have been inoculated yet have lost their insusceptibility because of a weakened immune system [4, 9]. These people include babies who are too young to be vaccinated, pregnant ladies who cannot get certain antibodies, and immunocompromised individuals, for example, those undergoing chemotherapy, HIV+ people, or transplant patients [4].

Yet, the medical advances of vaccines have led to individuals losing interest or belief in the severity of preventable diseases. Harmful disease such as measles and pertussis have been contained, so the greater public has not been exposed to the harmful effects [2, 4]. Therefore, harmful side effects of vaccines are seen to be the more dangerous as individuals begin to publicize them more. This causes a loss of confidence in vaccines. Experts propose that a "pyramid effect" causes this loss of concern [4]. In the model, the base of the pyramid is made up of the majority who benefits from the vaccine while the top of the pyramid represents a minority who does not support the immunization [4]. The top of the period is made up of people who either have been harmed or perceive harm [4]. In the evolving vocal society, the top of the pyramid that once existed as a quiet minority now has a voice to cause disruption in positive vaccine ideology [4].

Concurrently, numerous examinations have recently researched the job of security concerns, misguided judgments about infection hazard, and convictions that vaccines are insufficient as the major contributing elements in immunization refusal [4, 11]. But, these instances do not compare to how parents feel about the government and how this may influence the choices they make for their kids [11]. In the US, state government demands for required

vaccinations in children have consequences, where guardians who do not completely immunize their kids or who have not obtained proper forms are banned from public schools [11].

Conclusion

The increasing effectiveness of parental ideals that are against vaccines is causing there to be a higher likelihood that youths will become infected with pertussis. The act of neglecting to vaccinate one's child puts other individuals at risk. Not only are surrounding classmates at risk, but also newborn children and individuals with compromised immune systems [12].

The growth of these opposing views is causing a need for vaccine intervention [12]. This intervention causes for medical professionals and government officials to review the stipulations of vaccines and children [13]. Moreover, there must be better ways for individuals to appeal to parents who are against various methods of immunization [13]. It appears that statistics are not working, as parents express distrust of the government as well as the side effects of vaccines. Thus, there needs to be more involvement of third parties to influence vaccination [13].

The discrediting of medical assumptions is not the only battle that must be fought in achieving positive effects on the benefit of the population's health [4]. Public health officials must understand that the average American is not well-versed or experienced in the diseases that plagued humanity long ago [15]. To combat this issue the interventions must provide details and explain the likelihood of a disease killing a child [14].

Furthermore, it would be unethical to force an individual to change his or her religion or go against his or her faith for medicinal reasons. Thus, individuals who practice religion that does not allow them to undergo vaccinations must be better accounted for in dense populations

[3]. Understandably, these groups of people pose a threat to the health of children. However, if immunization is controlled these children will have a better quality of life.

Effect on the U.S.

The U.S. population has a dwindling immunity towards various diseases that are eradicated by vaccines. Recent data from the National Immunization Survey indicate the percentage of children reaching age two years without having received any vaccinations has increased gradually, from 0.9% for children born in 2011 to 1.3% for children born in 2015 [4] [9]. Other information indicates that some children who were under-vaccinated in early childhood do not catch up before kindergarten entry [8]. This highlights the importance of school entry vaccination requirements to ensure catch-up vaccination of unvaccinated and undervaccinated children.

In 11 of the 28 states detailing 2017–2018 time period or provisional enlistment information, the level of kindergartners in these gatherings at the season of appraisal surpassed the rate with an exception from at least one immunizations, standing for a gathering of kids who could be completely inoculated with fitting development [8]. CDC urges projects to gather and utilize these facts to distinguish populaces of unvaccinated students [8]. Practically all states could accomplish \geq 95% inoculation inclusion if unvaccinated nonexempt children were immunized as per nearby and state immunization approaches [8].

From 2017 to 2018, median kindergarten vaccination coverage was close to 95% TdaP [8]. The number of states with coverage \geq 95% increased from 23 to 25 for TdaP [8]. Coverage increases in selected states might result from modifications to state programs [8]. For example, Pennsylvania reduced its provisional enrollment period from 240 days to 5 days with a medical

certificate indicating the scheduling of missing vaccine doses [8, 9]. The Indiana State Department of Health initiated report cards for schools displaying kindergarten immunization coverage rates and built a bidirectional interface that increased the amount of data in their immunization information system [8, 9]. Kentucky removed the provider signature requirement when printing identification of vaccination status, allowing school nurses to use the immunization information system certificate to document vaccination history [9]. In Virginia, the number of local health departments participating in back-to-school immunization clinics for children entering school increased [9]. In addition, most providers follow up with parents to ensure proper vaccination.

Figures



Key (Figure 1)			
Cases	AR	OR	AR Pop
All Ages	99.5	22.8	11
2-20mo	99.3	19.3	12.2

Figure 1: This figure represents Anticipated Risks (AR) of unvaccinated children, the average risk (OR) of vaccinated children, and the Anticipated Risk of the population (AR Pop). This displays the extremity of a child contracting a disease because they have not been vaccinated. This figure was modified from Lee, C., et al., Hurdles to herd immunity: Distrust of government and vaccine refusal in the US, 2002-2003. Vaccine, 2016. 34(34): p. 3972-8.



Key (Figure 2)	
Reason	%
No Referral	25
No Follow-up	23
Personal Reason	20
Invalid	18
Contraindication	
No Prenatal Care	8
Valid	3
Contraindication	
Unknown	5

Figure 2: This figure is modified from Bednarczyk, R.A., Examining the "why" of vaccine hesitancy. Health Psychol, 2018. 37(4): p. 316-317. It represents the following: No Referral, No Follow-up, Personal Reason, Invalid Contraindication, No Prenatal Care, Valid Contraindication, and Unknown. These labels are in reference to parents who have not vaccinated their children. Each group depicts a specific reason in which vaccination is avoided.



Кеу		
(Figure 3)		
Year	Unvaccinated	Vaccinated
2011	1.9	1.8
2012	1.9	1.5
2013	1.7	1.7
2014	1.5	1.2

Figure 3: This figure displays the likelihood that a child would contract autism from receiving the TdaP vaccine. The percentages that are displayed do not have a high difference between children who have been vaccinated and those who were not. This suggests that there is no correlation between the vaccination and autism. This figure was modified from 2. Becerra-Culqui, T.A., et al., Prenatal Tetanus, Diphtheria, Acellular Pertussis Vaccination and Autism Spectrum Disorder. Pediatrics, 2018. 142(3).

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