The Uptake of the Mumps, Measles, and Rubella Vaccine

Mary Foster Gaillard

Health 2400 Section 001

Introduction

Vaccination is a highly controversial topic in America. In 1998, Andrew Wakefield and his colleagues published a case study called the *Lancet*, which incorrectly linked the measles, mumps, and rubella vaccine (MMR) with behavioral regression and developmental disorder in children. This article had numerous suspect factors, such as a population size of only twelve, uncontrolled design, and the speculative nature of many of his conclusions, that should lead any person to question its validity. However, the paper was widely accepted and vaccine rates for MMR began to drop because parents were nervous about the risk of autism from the vaccination. The article was later rejected for falsified evidence and Wakefield himself released a statement rejecting its claims. (Rao and Andrade, 2011) However, there were lasting effects in MMR vaccination uptake resulting from this erroneous article and some that can still be seen today.

The MMR vaccine prevents three separate viruses. Measles is a virus that affects children and used to be quite fatal. The symptoms include fever, dry cough, runny nose, sore throat, inflamed eyes, a skin rash of spots that flow into one another, and white spots in the mouth on the inner lining of the cheek, called Koplik's spots. The infection begins with an incubation period for the first 10-14 days where children are asymptomatic. Throughout the next week, the other symptoms start to occur mildly and then increase to a severe rash and fever. The danger of measles comes from the numerous complications that can occur such as, ear infection, bronchitis, laryngitis, croup, pneumonia, and encephalitis. These complications occur due to inflammation of the larynx or bronchial tubes and are very dangerous. (Goldman, 2016) Without a vaccine, measles is a deadly virus, killing on average 2.6 million people per year before the introduction of the vaccine in 1963. (WHO, 2019)

Mumps is also protected from the vaccine and is a viral infection that causes swelling in the salivary glands located near your ear. Common symptoms include fever, headache, weakness/fatigue, loss of appetite, pain while chewing or swallowing and in the swollen salivary glands. Mumps becomes a dangerous virus when swelling occurs in other parts of the body, such as the brain, pancreas, or testicles in males. Inflammation of the brain, encephalitis, can cause neurological problems and can become fatal. Other rare complications include hearing loss, heart problems, and miscarriage if the disease is contracted during pregnancy. (Kliegman, 2016)

Before the MMR vaccine, there were only about 186,000 cases reported each year, but experts speculate that the actual number of cases is much higher due to underreporting. (CDC, 2020)

Finally, Rubella is a virus that is very similar to but less contagious than measles. It poses its greatest threat to unborn children whose mothers contract the virus during pregnancy. The symptoms include mild fever, headache, runny nose, inflamed or red eyes, enlarged lymph nodes, aching joints, and a rash that spreads from the face, to the trunk and then to limbs. Rubella is very mild in most cases and once someone has had it they become immune. Complications become serious for unborn children whose mothers have the virus and can lead to growth delays, congenital heart defects, defects in other organs, intellectual disabilities, cataracts and deafness. (Cunningham, 2018)

The CDC recommends that children should get the MMR vaccine starting with a first dose between twelve and fifteen months and then a second dose between four and six years old. Just one dose of the MMR vaccine is 93% effective against measles, 78% effective against mumps and 97% effective against rubella. Two doses of the vaccine results in 97% effectiveness with measles, 88% with mumps and 97% with rubella. (CDC, 2021) Currently in the US, 90.8% of children are vaccinated for measles, mumps and rubella by 24 months, which is below the CDC recommended level of 95% vaccination (CDC, 2021).

Healthy People 2030 identifies one of their main health behavior objectives to be increasing vaccination rates. Although most infants and children are vaccinated, there are some communities where vaccination levels are so low that diseases that were once eradicated in the US are becoming prevalent again. Healthy People strives to implement new strategies to increase vaccination rates by teaching people the importance of vaccines, sending reminders, and increasing the availability and ease of getting vaccines. (Healthy People 2030, n.d.)

Theory

Health theories are used by scientists when they try to understand the motivation behind people's behaviors and how to implement effective strategies to change or improve behaviors. Most health theories are built around a group of constructs, concepts that are developed or adapted to

fit the theory. These constructs organize the different theories and allow scientists to apply them to multiple different health behaviors. Two theories that are commonly used when studying vaccination uptake are the Health Belief Model and Social Cognitive Model.

Health Belief Model

The Health Belief Model focuses on how one's beliefs and attitudes on the behavior will affect their decision to change or not. It is built on the constructs of perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self efficacy. Each of the constructs aid in explaining the overall reason a person does or does not change their behavior based on their beliefs and attitudes. (Jones, et al., 2015) When applied to vaccination uptake, the health belief model shows that an individual's vaccine behavior is dictated by their perceptions of both the disease and its related vaccine.

A study was conducted in Shanghai, China in 2017 on the perceptions of the MMR vaccine by caregivers based on the health belief model. The study compared the caregiver's views on the measles and pneumococcal vaccines. Immunization clinics in 209 townships surrounding Shanghai gave out surveys to caregivers when they came to vaccinate their children. There was one question to measure each part of the constructs of the health belief model on the survey using a 5-point Likert scale. The results found that the perceived necessity of the vaccine was 93%, perceived prevalence was 2.3%, disease experience was 18.6%, perceived norm was 4.03%, perceived effectiveness was 3.81% and that perceived safety was 3.92%. (Wagner, et al., 2017)

This study found that in order to increase the uptake of vaccinations in middle income countries it is crucial to educate caregivers and change their beliefs and attitudes about the vaccine. The strongest association between the questions on the survey and the actual uptake of the vaccine was for perceived vaccine necessity. This would fall under the construct of perceived susceptibility. The more likely a caregiver thinks it is for their child to get measles, mumps or rubella, the more likely they are to get their child vaccinated (Wagner, et al., 2017).

The Theory of Reasoned Action and Planned Behavior

Another theory that is commonly used by health scientists is the theory of reasoned action and planned behavior. This theory attempts to connect the relationship between people's attitudes and their behaviors by focusing on the rational and cognitive decision-making processes. The TRA focuses on intentions behind motivation and how that leads to making decisions. The constructs for this theory are behavioral beliefs, evaluation of behavioral outcomes, normative beliefs, motivation to comply, control beliefs and perceived power (Kurland, 1995).

In 2012, in a midwest suburban community , an email survey was sent out to a university population, including both faculty, staff, undergraduate, and graduate students. The survey was designed to utilize the constructs of the theory of reasoned action and planned behavior and the individual's intention to get the human papillomavirus vaccine (HPV). Although this study was not performed in relationship to the MMR vaccine, it is still applicable to the intention and behavior behind vaccine uptake as a whole. (Britt, et al., 2014)

The results of this study showed that the greatest correlation between the constructs of the TRA and the uptake of the HPV were from normative beliefs. This result is supported by the fact that more often than not college students are highly influenced by their peers. The norms of their fellow students in getting a vaccine would have a high effect on whether or not they also got the vaccine. In a similar way, whether or not caregivers give their child the MMR vaccine can be highly correlated with the norms of the area they are living in. This study showed that the TRA can be applied to explain the relationship between a person's intentions and their behavior in regards to vaccine uptake. (Britt, et al., 2014)

In summary, the Health Belief Model and the Theory of Reasoned Action and Planned Behavior can both be applied to further understand the relationship between an individual's attitudes, beliefs and their behaviors. The two studies showed that perceived susceptibility and normative beliefs had the greatest influence on a person's decision to vaccinate or not. **

Intrapersonal Factors

Intrapersonal factors are a part of the social ecological model and are individual factors within a person such as a person's knowledge, attitudes, beliefs, skills, and perceptions (*Ecological Model,* n.d.). In regards to the decision to vaccinate, attitudes, beliefs, knowledge and perception all play a large role in the decisions individuals make.

As discussed earlier, one of the major concerns with the MMR vaccination is the belief that it causes autism, which was reported in an article by Wakefield. This belief has caused MMR vaccine uptake to decrease drastically since the report was published in 1998. After the report was further investigated, Wakefield retracted the validity of his study and admitted to falsifying the data. However, there are many concerned parents who still believe that the MMR vaccine can cause autism in children and do not vaccinate their children. (Rao and Andrade, 2011)

Another interpersonal factor that affects vaccine uptake is a caregiver's knowledge of the vaccine. If a caregiver understands the truth of what the vaccine will protect their child from and that the side effects are virtually irrelevant, they are much more likely to vaccinate their children. A study was conducted in 2017 on the effect of maternal education on reduction in childhood mortality. The study found that the odds of full vaccination uptake was 2.3 times greater in children whose mother had finished secondary or higher education. The overall conclusion of the study was that improving maternal education and knowledge was crucial for increasing vaccine uptake in children. (Forshaw, et. al., 2017)

Finally, some interpersonal factors that may contribute to a caregiver's decision to not vaccinate their child include socioeconomic status (SES), race, and education. The 2008 Behavioral Risk Factor Surveillance System (BRFS) was used to find the disparity between the rate of girls receiving the HPV vaccine in areas of poverty, middle income, and wealth. Although this study was not conducted for the MMR vaccine, the principles discussed can still be applied to its uptake as well. The results of the study found that areas below the poverty line had overall lower vaccination rates. (Pruitt & Schootman, 2010) Socioeconomic status can affect one's ability to be vaccinated based primarily on access to vaccines. In many rural cities there are no clinics where

vaccines are available. The cost of the vaccine can also be a large barrier for those with a low socioeconomic status.

Interpersonal Factors

Interpersonal factors are also a part of the social ecological model and these include influences from relationships with others and their attitudes and beliefs. Interpersonal factors are affected by those in circles closest to you, such as family, friends, classmates, co-workers, etc. In regards to the decision to vaccinate or not, the decisions the people in your life around you make can influence your own decisions heavily (Ecological Model, n.d.).

A study was conducted among the perspectives of Somali mothers on the MMR vaccine in 2018. The study found that there was a strong correlation between the opinions of friends and family members of the mothers and their decision regarding the vaccination. The study was conducted using an in depth interview process over the phone where interviewers asked probing questions to get to the bottom of the true factors affecting the mothers' decision-making process. The majority of the mothers in the study who choose not to have their child vaccinated or to delay the vaccination said *"I ask other mothers who have had children and have more experience."* Another common response was the spread of concern about the risks associated with the MMR vaccine from mother to mother. The perspectives of friends and their surrounding community had a large impact over whether or not these mothers vaccinated their children. (Jama, et. al., 2018)

Schools mandating vaccination for children has also had a large impact on the uptake of vaccinations. In all 50 states, the MMR vaccine is required for children to enter into grade school. (Immunization Action Coalition, 2019) A research study was conducted in 2019 to determine the relationship between vaccine rates and schools mandating immunization. The study looked at schools across the US and found that in schools where the vaccine was mandated, the uptake among students was much higher. Although there are exemptions for vaccine mandates, this was found to be a successful method of increasing immunizations. (Greyson, et. al., 2019)

Organizational, Community, Environment, and Policy Factors

Organizations, communities, environments, and policies can all affect one's decision when it comes to vaccinating their child or not. An organization that affects most parents day to day lives is their children's school. As stated previously, schools play a large role in a parent's decision to vaccinate or not because most schools mandate certain vaccines before children can attend. This is also an example of policy affecting behavior. In all 50 states, the MMR vaccine is required for children to enter into grade school. (Immunization Action Coalition, 2019) However, there are certain laws in place that allow a child to be exempt from the vaccination based on medical, philosophical or religious reasons.

An example of a medical exemption from vaccination would be for children who are considered immunocompromised, which could come from chemotherapy or HIV/AIDS. Philosophical reasons for exemption are non-religious and non-medical. These exemptions focus on individuals rather than communities and are mainly for people who have a strong objection to vaccinating their children. When Wakefield and his colleagues published their article, *Lancet*, it began a sweeping movement of "anti-vaccers" and there are people who still believe in the falsehoods of the study today. Finally, there are religious exemptions from the vaccine mandates for schools. These are more focused to a community level of denominations whose beliefs are in disagreement with vaccination. An example of this would be the Roman Catholic church. Until recently, Catholics opposed the MMR vaccine because the rubella strain had developmental origins of cells from an aborted fetus. Also, the Church of Christ Scientist opposes all vaccines just in and of themselves. (Bowes, 2016)

However, since the 2019 measles outbreak, it has become increasingly more difficult to get an exemption for the MMR vaccine. In 2019, Washington state changed their exemption laws to remove the option for a personal/philosophical exemption. This law was changed due to an ongoing measles outbreak in Washington and across the country. (Washington State DOH, 2019) In the midst of the same outbreak, New York passed legislation to become the fifth state that only allows medical exemptions for the MMR vaccine, along with California, Maine, Mississippi, and West Virginia. (Sandstrom, 2019)

The effects of school and policy factors can also be seen across communities. People who have anti-vaccination beliefs tend to cluster into communities that are typically affluent, homogeneously caucasion, and surprisingly enough, have high quality of healthcare. In California, communities even had MMR vaccination rates fall to only 25% for the 2014-2015 school year. (Bowes, 2016) This is most likely the cause of California restricting the exemptions for the vaccine to only be for those who it is medically necessary. Communities play a large role in the decision to vaccinate or not because it is easy for a person to go along with the norms and beliefs of the people surrounding them.

Many beliefs about vaccinations originate from the environment one lives in. If the parents of an individual strongly oppose vaccination, they are more likely to not vaccinate their children. This can also be applied on a larger level. As stated previously, some states have stricter laws on exemptions than others allowing for a variety of vaccination rates across the country. In 2019, Colorado had the lowest percent vaccinated of 87.4%, far below the recommended 95% by the CDC. Mississippi had the highest coverage of 99.2%. (Seither, et al., 2019) The environment surrounding a person, whether that be the state they grew up in or the home they live in, can also affect their decision to get the MMR vaccine.

Suggestions for Intervention

Factors mentioned throughout this paper all contribute to an individual's decision to vaccinate their child. The most successful intervention methods to increase vaccine uptake target multiple factors at once, such as intrapersonal, interpersonal, organizational, community and environmental factors. While discussing intervention methods, it is crucial to discuss the importance and the changeability of factors. Some factors will have a higher priority based on mortality and morbidity rates while others may be less important. There will also be some that are easier to implement and change than others. These two components combined can help direct successful interventions. The majority of problems when it comes to MMR vaccine uptake originate from caregivers not understanding or believing false information about the vaccine.

A study conducted in 2017 of the most successful interventions in regards to increasing vaccine uptake found that interventions done in conjunction with other interventions were consistently

more effective than those done in isolation (Frew and Lutz, 2017). One positive intervention included in the study was on the intrapersonal level. It directly targeted parents of newborns by sending them reminders when their babies immunizations were coming up as well as educating them on the importance of these immunizations. This strategy is mainly focused on changing personal beliefs and attitudes, intrapersonal, but it would need to be maintained by an organization (Frew and Lutz, 2017). This intervention strategy would fall into the more important and more changeable category. Increasing vaccination uptake of newborns is crucial to prevent disease or even death of children (Geier and Kern, 2019). This strategy is also very changeable because it is not difficult or costly to implement a monthly newsletter or reminder for vaccination with some education for the caregiver included.

Another successful intervention found in the study was implementing electronic health records at the clinical-level. Electronic health records have revolutionized the way that health care systems function by coordinating care, standardizing documentation, streamlining paperwork, and decreasing administrative work. Electronic health records can be programmed to send reminders to caregivers, as mentioned previously, when their child needs a vaccine. Computerized immunization registries provided a sustained increase in vaccination uptake by 26% and 47% over a ten year period (Frew and Lutz, 2017). Implementing EHRs is a bit more difficult to change because of the cost of digitizing an entire health system; however, it is still very important based on its sustained positive impact on vaccination uptake.

A comparable study was conducted in 2018 to address the lack of immunizations that immigrants have when migrating to Europe. These interventions were focused on maintaining cost-effectiveness while improving vaccination uptake. Their three methods were mobilization/community outreach programs, planned vaccination programs, and education campaigns. This multilevel intervention strategy was effective in increasing the vaccination uptake of migrants as they entered Europe. Bringing vaccines into the community in free mobile health clinics, was found to be a very effective strategy. Again, the importance of education is highlighted in this study. Teaching migrants as well as caregivers what the vaccine is made of and its effectiveness has consistently shown increased uptake. This strategy targeted the interpersonal level through education, organizational level through planned vaccine programs, as

well as the community level with community outreach programs (Hui, et al., 2018). This multilevel intervention strategy would be very important because 763 million people immigrate into Europe yearly and a large majority of this population is unvaccinated. In 2017 and 2018 there was a measles outbreak which spread due to the large population of unvaccinated migrants, again showing its importance. This intervention is also changeable. While it would take a large effort to coordinate all of these strategies, it is crucial to the prevention of the spread of disease, which would make it the highest priority (Hui, et al., 2018).

All of these interventions targeting increasing vaccine uptake can be applied specifically to the MMR vaccine. Increasing vaccine uptake will be most effective with a multilevel strategy targeting caregivers. The first dose of the MMR vaccine is recommended for children between twelve and fifteen months old and the second for children between four and six years old (CDC, 2021). Children are not making the decision to vaccinate or not, which is why targeting caregivers is pivotal to increasing uptake. Education, community clinics and increasing access to vaccination are the most important ways to increase uptake. Due to misconceptions and the falsified article published by Wakefield, there is a lot of controversy surrounding the MMR vaccine. The most important intervention would involve educating caregivers of the false claims included in the Lancet study as well as the effectiveness of the vaccine and the mortality rates associated with measles, mumps and rubella.

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Table 31. Vaccination coverage for selected diseases by age 24 months, by race and Hispanic origin, poverty level, and location of residence: United States, birth years 2010–2015. (2021, March 01). Retrieved March 24, 2021, from https://www.cdc.gov/nchs/fastats/immunize.htm

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