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Vaccinations: Weighing the Risks and Benefits

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Abstract

Research has proven that vaccines prevent disease. Important medical organizations conclusively support and advise the administration of vaccinations to prevent diseases that once caused devastating effects both in the individual who contracted, and in communities where these diseases spread. While some groups protest against the constitutionality of vaccinating, others counter that failure to do so subjects the unvaccinated to illness and death by contracting and spreading of the sickness. Despite statistics on reduced incidence of diseases with few consequences as a result of vaccine-induced passive immunity, fears of harm secondary to vaccination loom. In the 21st Century, many people are unaware of diseases that still occur in undeveloped countries due to herd immunity through a majority vaccinated population. The diseases, however, are only a plane ride away. Due to globalization, vaccine preventable diseases can land in anyone's kindergarten. Although the link between vaccination and autism was pinned to research that was subsequently retracted, the rate of not vaccinating children continues to rise and these unvaccinated children pose risk to others who are unable to receive vaccines and compromise the core herd immunity. As modern science strives to demonstrate vaccine safety and efficacy, despite the rare but undisputed adverse effects, individual decisions to vaccinate remain a complex process with differences in perception, beliefs, and values to consider. These tenets will manage to produce research and evidence to support both pro-vaccination and against-vaccination in an attempt to determine if the potential benefits of getting vaccinated outweigh the detrimental side effects that may result. Further, a better understanding of the ramifications secondary to original research that noted negative correlations among vaccinated individuals and the vaccines they received will be understood. These controversies are the ripples experienced as a result of retracted and unethical research.

Introduction

We live in an age of incredible technology, discovery and medicine. Smartphones, spaceships, and bionic eyes are no longer reserved for science fiction. Vaccinations are among the groundbreaking medical discoveries which "allow us to engage our adaptive immune systems to produce highly specific antibodies and immunological memory against a potential future infection" (Federman, 2014). Through exposure to an inactivated pathogen in a safe way, the body's innate immunity learns how to properly adapt to the previously deadly pathogen. Still though, over two hundred years following Edward Jenner's successful use of cowpox material to create immunity to smallpox, in 1796, there are still those hesitant to make use of vaccinations for themselves and their children (Riedel, 2005). Consequently, it is quite concerning that an anti-vaccination movement persists. Particularly, people are concerned over a potential correlation between vaccinations and autism (Federman, 2014). Is vaccination so harmful that it is worth not getting vaccinated? Abstaining can put others at a higher risk of developing the given disease because there will be more disease carriers in the population. Or is vaccination harmless, or at minimum, do the benefits greatly outweigh the potential harmful side effects? Further, is it a matter of science or simply emotion discomforting those against vaccinations?

Methods

The research obtained regarding the potential side effects and benefits of various vaccinations was collected from a variety of sources. Most notably was the use of Touro's online library which provides access to databases such as Pubmed, Proquest, and more. Further, additional articles were found through Google Scholar searches of relevant original and peer reviewed articles on the topic. After reviewing an adequate number of articles on the good and bad of vaccinations, evidence was compiled which attempts to answer the research question.

Potential Benefits of Vaccinations

An important example of an efficacious vaccine is the Smallpox vaccination. In fact, the only way to be protected from Smallpox is through vaccination. Though Smallpox was once a virulent disease taking the lives of over one third of those infected, it has since been eradicated by means of vaccinations (Fenner et al., 1988). The protection from Smallpox, influenza, polio and many other diseases and viruses are already well-known vaccination benefits. Consequently each specific type of vaccination will not be directly expressed in this paper; rather, on the CDC website (2015) the entire list of dozens of possible vaccinations can be located. Instead, further benefits associated with vaccination uptake will be presented.

Are vaccinations effective at eradicating diseases? Regarding the effectiveness to eradicate an epidemic, there is a concept known as "herd immunity." Fine (1993) explains that "If an infection is to persist, each infected individual must, on average, transmit that infection to at least one other individual. If this does not occur, the infection will disappear progressively from the population." Note, there are those who are too young or too sick to become vaccinated, without herd immunity, many people will be at risk. Therefore, the higher percentage of those vaccinated, the higher the efficacy of any given vaccination in

protecting not only those vaccinated, but also the population as a whole.

Are vaccinations worth the expense? Vaccinations are cost effective and also save considerable amounts of money in healthcare costs. Zhou et al. (2014) determined that for children born in the United States in 2009, the nine vaccinations included in their study will prevent 20 million cases of disease and save 42,000 children from early deaths. Further, the same vaccinations will yield a savings of $13.5 billion in direct medical and non medical costs, including factors such as treatments for a primary infection, travel costs, special education and equipment costs for children disabled by disease, as well as further costs in extended hospital stays caused by medical complications. Furthermore, an additional $68.8 billion will be defrayed in total societal costs, most notably lost wages. The net savings would total a staggering $82.3 billion.

Though $82.3 billion is no small price, still this study did not include the Influenza vaccination, in their estimate. Therefore, the determined financial benefits of vaccinations may be understated. For example, during the eleven influenza epidemics in the United States from 1969 until 1994, there were between 130,000 and170,000 influenza-associated hospitalizations per epidemic with more than 20,000 influenza-associated deaths in 5 of epidemics; and over 40,000 influenza-associated deaths occurred during the other 6 epidemics. (Pleis & Gentleman, 1998). Furthermore, this study is limited to the United States, globally there exists a more vast market for saving. The additional money that is saved in healthcare costs, the further resources that can be allocated for vaccine research. For example, it is believed that diseases like cancer, epilepsy, and many more potentially can be prevented with vaccines but more research is needed. Regardless if these cures are a future possibility, there are plenty other worthy uses for the extra money that can be saved through becoming vaccinated.

Today healthcare workers are able to be protected from their sick patients with vaccine preventable viruses. Healthcare workers can be immunized and safely care for sick patients. They need protection not only from airborne viruses but also blood borne viruses contractible via shared needles. In the United States, it is estimated that there are 385 thousand cases of reported needle stick injuries per year. Incidentally, this number is an underestimation because it is expected that a significant number is unreported (Elmiyeh et al., 2004). People need to continue working and do not report needle stick injuries because they fear getting reprimanded for using equipment improperly.

Another potential benefit of vaccinations is to protect unborn children. Mothers who have received vaccinations can protect their unborn children from birth defects caused by certain viruses and further, vaccinated communities can help eradicate diseases to benefit future generations. Between 1963 and 1965, prior to the licensing of the rubella vaccine in 1969, a global rubella outbreak caused the deaths of 11,000 babies, and also birth defects in 20,000 babies in the United States. Therefore when women are vaccinated as children against rubella, they have significantly decreased the chance of passing the virus to their unborn or newborn children. This potentially eliminates the numerous birth defects associated with rubella, such as hearing and or vision loss, heart problems, congenital cataracts, liver and spleen damage, and mental disabilities (CDC, 2011). These birth defects can decrease quality of life and often require resources to help improve outcomes.

The last benefit is that research indicates that some viruses cause cancer. For example, the human papilloma virus (HPV) has been associated with cervical cancer (Marur et al., 2010). Therefore, it is important to realize that vaccinations are important to immunize against diseases to prevent the onset of side effects that can result; some of these may ultimately be lifesaving.

Potential Side Effects of Vaccinations

Regarding the possible negatives of vaccinations, it is important to consider the evidence for a correlation between vaccinations and developing autism. During the late nineties the link dissuaded people from taking vaccinations and now almost twenty years later the fear lingers. A clinical study found that "behavioral problems had been linked, either by the parents or by the child's physician, with measles, mumps, and rubella vaccination" (Wakefield et al., 1998). This early report became widespread and propelled the anti-vaccination movements taking place even today. The study was preformed using twelve children ranging in ages three to ten, with eleven of them male. Prior tests determined that all twelve children showed satisfactory achievement of early milestones. These children all lived normal lives, but then lost certain skills, notably the ability to communicate. Further, they all had gastrointestinal symptoms. e.g. diarrhea and abdominal pain. The children underwent assessment and review of their gastroenterological, neurological, and developmental records. Results indicated all twelve children had intestinal abnormalities, ranging from aphthoid ulceration to lymphoid nodular hyperplasia. Additionally, "onset of behavioral symptoms was associated, by the parents, with measles, mumps, and rubella vaccination in eight of the twelve children with measles infection in one child, and otitis media in another" (Wakefield et al., 1998). They each developed autistic behavioral disorders, nine of which developed autism. Disintegrative psychosis and possible post-viral or vaccinial encephalitis were less prevalent, representing one and two cases respectively.

It is suggested that autistic-spectrum disorders have a direct connection to intestinal dysfunction (Wakefield et al., 1998). In addition to this study, there are previous studies that link the connection between a dysfunctional or inflamed intestine and autism. For example, the "opioid excess" theory of autism, proposed originally by Panksepp (1979) explains that autistic disorders result from "incomplete breakdown and excessive absorption of gut-derived peptides from foods, including barley, rye, oats, and caesin from milk and dairy produce." These remaining peptides can stimulate the formation of harmful peptidase enzymes which break down endogenous central-nervous-system opioids, leading to disruption of neuroregulation and brain development (Shattock, et al., 1991). Interestingly, it has been observed that following removal of a provocative enteric antigen, the children achieved symptomatic behavioral improvement (Lucarelli, et al., 1995).

Still, the debate around the cause of autism remains controversial, and some, like Wakefield, postulate the incidence is correlated with childhood vaccination. To examine this hypothesis a retrospective study of 537,303 randomly selected children's cases were examined to determine association of the Measles, Mumps, Rubella (MMR) vaccine and autistic disorder. Of the group, a total of 440,655 children had received the MMR vaccine, with only 758 children diagnosed with some degree on the autistic spectrum, of which 316 were diagnosed with the most severe on the spectrum, autistic disorder. The incidence rate was 0.17% which is insignificant compared to the 7.7% to 11% range among various unvaccinated groups. Madsen et al, (2002) therefore concluded that there is no scientific causation between vaccination and autistic disorder or other autistic spectrum disorders.

Regarding the two conflicting studies, the size of their corresponding test groups is incomparable. Wakefield (1998) performed the study on just 12 children in one time frame, while Madsen conducted a retrospective study on almost half a million vaccinated children over the course of a few years. Though Wakefield seemingly proves a correlation between developing gastrointestinal problems following an MMR vaccination, more research is required to be conclusive that vaccinations can cause autism. However, in Madsen's (2002) study utilized about half a million children studied over multiple years. Therefore, Madsen's conclusion can be trusted that autism is not a side effect of vaccinations.

In an addendum to reinforce his conclusion, Wakefield added another 40 patients to his study, with 39 having the autistic syndrome. Still, his total of 52 patients is not as significant as the broader study done by Madsen. Another potential issue with Wakefield's study is that he quotes Lucarelli who explains that autism is reversible; this is a powerful claim that has yet to be confirmed. Furthermore, the Lancet released an official statement retracting Wakefield's study. Here is their full statement:

> Following the judgment of the UK General Medical Council's Fitness to Practice Panel on Jan 28, 2010, it has become clear that several elements of the 1998 paper by Wakefield et al are incorrect, contrary to the findings of an earlier investigation. In particular, the claims in the original paper that children were "consecutively referred" and that investigations were "approved" by the local ethics committee have been proven to be false. Therefore we fully retract this paper from the published record (the Editors of the Lancet, 2010).

In spite of this retraction, people clung to this concept that there is a relationship between vaccinations and a development of autistic spectrum disorders. It is astounding that the very Wakefield paper which led people to believe the MMR vaccination causes autism was retracted due to ethical misconduct. In addition the Lancet retracted the Wakefield paper for nondisclosure of financial interests. They reported that their sampling was randomized, however, in fact, it was selective. For example, in order to attract subjects, the researches offered a fee for parents of children who received the MMR vaccine and also had a previous diagnosis within the autism spectrum.(Sathyanaraya Rao & Andrade, 2011).

Not only does Madsen (2002) amply prove there is no correlation between vaccinations and autistic disorders, Wakefield's study has since been completely retracted. Perhaps the most appalling long-term affect is that the myth is so deeply ingrained that parents are refusing to vaccinate their kids out of fear of harm, and, unfortunately, some of these kids will or have already succumbed to the greater danger of contracting a vaccine-preventable illness. Because the official retraction was a mere paragraph in length and lacks detailed explanations, it slipped under the radar of the common folk and now people still believe Wakefield has legitimacy.

There is a potentially serious complication from vaccine administration known as Guillain–Barré Syndrome (GBS), which is a paralysis that begins on the lower extremities and migrates up the body. The legs become numb and as it ascends the body it leaves paralysis of muscles in its wake. An immune response is triggered that directly destroys either the myelin sheath surrounding the peripheral nerves or even the axon itself, leaving scar tissue in its midst. Unfortunately, if not promptly treated it will paralyze the breathing center, which is located at C3 of the cervical spinal column and breathing will require mechanical assistance (Koski, 1994). Dr. Tamar Lasky and her colleagues

studied the 1992-1993 Influenza Seasons and did in fact discover a direct increase in cases of Guillain–Barré Syndrome within the first six weeks following vaccination. At first glance, this discovery should shy people away from getting vaccinated. However, Lasky determined the increased risk to be only an additional 0.61 cases per million vaccinations. Further, even after an adjustment to include four factors that would make the original estimate conservative, their most accurate estimate of the attributable risk would be 1.1 case per every million vaccinations. Therefore Lasky argues that, "Even if Guillain–Barré syndrome were a true side effect in subsequent years, the estimated risk for Guillain–Barré syndrome of 1 to 2 cases per million persons vaccinated is substantially less than that for severe influenza, which could be prevented by vaccination in all age groups, especially persons aged ≥65 years and those who have medical indications for influenza vaccination" (Lasky et al., 1998). Therefore, despite the reality of the GBS complication caused by vaccinations, many still opt to prevent serious diseases by vaccination. Although avoiding vaccinations still remains controversial to many, the relative risk of experiencing a complication is low, and it could be considered neglect by parents to abstain from vaccination of children in an era where vaccines can protect these children from many serious diseases. As was aforementioned in this paper, the disproportionate number of 20,000 lives that would be saved from influenza epidemics alone far outweighs the minimal risk of contracting GBS (Pleis & Gentleman, 1988).

Each year there are 30,000 Vaccine Associated Events (VAE)s reported, with 13% comprising disability, hospitalization, serious illness, or death. While most of the reactions were classified as mild involving fever, irritability, or local reactions such as mild redness at the site of the injection that is sometimes caused by the preservative thimerosal or other innocuous inflammatory response (Vaers.hhs.gov, 2015). Even with the reporting system, many events are thought to occur by coincidence, as other syndromes such as Sudden Infant Death Syndrome (SIDS) occurs without any etiological basis (Vaers.hhs.gov, 2015). As Hardt et. al. (2013) point out, vaccine associated disease incidence is reduced in populations to the point of inability to remember what these diseases are and how they can harm. This phenomenon may cause vaccine adverse reactions to loom as predominant errs in how we provide healthcare and disproportionately place fear of harm above disease prevention in the minds of well-meaning caregivers.

An additional potential side effect from vaccinations can stem from the actual vaccinations. As was explained, a vaccination is effective through exposure to inactivated harmless pathogens. In some cases, though, the pathogen can potentially become harmful in the future. An example is varicella, commonly known as chickenpox, a vaccine-preventable illness which is a very common and usually benign childhood disease. Chickenpox however can cause serious painful complications in those who contract the illness in adulthood, in the form of Zoster, commonly known as shingles. The vaccine immunity wanes as one ages, and the dormant virus introduced with the vaccination can strike. As the body's ability to mount an immune response declines, the people will be more dependent on re-administering of the given vaccine (Shuette & Hethcote, 1999). This side effect may scare off potential patients, though in light of this potential side effect, maybe it is in fact more beneficial to withhold from the chicken pox vaccination. Though, a simple solution would be to receive a new vaccination every number of years. Further, Shuette and Hethcote (1999) discovered that even when those vaccinated for Chickenpox develop Shingles as adults, the symptoms are milder, since they still have some immunity, compared to those never vaccinated. Even if chicken pox vaccinations have a reason to be withheld, this side effect is not a reason to refrain from other types of vaccinations, such as Polio, Smallpox or the MMR vaccinations.

Discussion

In conclusion, research has not been able to produce a correlation between autism spectrum disorder and vaccination. Still, it is important to acknowledge the presence of fears, distrust, and other reasons to oppose vaccines. Although the adverse reactions are minimal, to the person who suffers an adverse event that is one too many. The Food and Drug Administration (FDA), Centers for Disease Control and Prevention (CDC) and American Academy of Pediatrics (AAP) all support vaccine administration, and have successfully reduced prevalence of vaccine preventable diseases. However, we must ensure that appropriate education is disseminated to caregivers of children to protect the safety and lives of others by supporting vaccine administration so people with inability to receive vaccines will be better protected against vaccine preventable diseases. By ensuring a robust vaccination program, and supporting the expansion of research on vaccine preventable diseases, we can help develop vaccines for illnesses and diseases that currently remain untreatable. Perhaps new vaccine research might dispel vaccine myths which will increase the rates of vaccination, protecting more of the population.

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