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Potential Solutions to MMR Vaccine Denial

Introduction

The world before 1796 was a very different place. The threat of smallpox loomed ever-present in the minds of the poor and rich alike, and why not? Smallpox in that day was one of the earth's great scourges, responsible for the death of world leaders like King Louis XV of France and Queen Mary II of England. Smallpox epidemics would periodically ravage the far corners of the earth, killing many who contracted it and leaving the others either pockmarked for life or otherwise blinded and maimed (Roth and Fee).

It seemed there was little that could be done about this silent, ravenous killer. That is, until the discovery of the world's first vaccine by Edward Jenner, a British polymath who got the idea after reportedly "hearing a Bristol milkmaid boast, 'I shall never have smallpox for I have had cowpox. I shall never have an ugly pockmarked face'" (Stern and Markel). Jenner was able to show that stable maids who had contracted cowpox were rendered immune to smallpox, and, in the master stroke of genius of his day, he demonstrated that a person could be protected against smallpox by transferring tissue from a cowpox sore to an open wound.

Today, my generation's only knowledge of smallpox, the malady that had previously wrought such destruction and despair, comes only from what we can glean from books and other accounts of the disease. Indeed, the virus itself exists in only a handful of government-run, level-

four biohazard labs, safely locked away from the general population. This proverbial beast has been tamed, and we owe our deliverance to vaccines.

Yet even after immunology has proven its great worth to society over nearly two centuries, there are still those who cry foul about the benefits of certain vaccinations. Most recently, there has been an astonishing trend of parents refusing to vaccinate their children with the combined measles, mumps, and rubella (MMR) vaccine.

While resistance to vaccination is nothing new, the particulars of the new anti-vaccine movement's preaching have changed dramatically, now focusing on a specific inoculation. Following the publication of Andrew Wakefield's work in the British medical journal *The Lancet*, which claimed to have found a link between autism and the MMR vaccine, many parents decided that the MMR vaccine simply was not safe enough for their children. They continued to make this decision even after family physicians patiently communicated that no one has ever duplicated Wakefield's findings, and indeed the link between autism and the MMR vaccine has been disproven very concretely. So if parents are being informed by a supposedly trusted medical expert, why do so many still refuse the MMR vaccination?

The answer lies not in peoples' ignorance, nor the inability of doctors to communicate with their patients. Nor does the answer seem to lie within the heavy media coverage and scaremongering of the purported connection to autism, poll and immunization data suggest ("Media Coverage of Alleged"). So where is one to look for an effective explanation for vaccine refusal? I believe the phenomenon is best explained by theories posited by modern psychologists, who note that emotional stress heavily compromises our decision-making faculties and prevents people from making an otherwise easy correct decision. Furthermore, psychological research

suggests that the only truly effective way to appeal to people who make rash decisions is to play with their emotions in much the same way that the decision itself does.

The Efficacy and Impact of the MMR Vaccine

Why is the MMR vaccine so important, anyway? What little experience newer generations have with measles, mumps, and rubella suggests that these diseases are no longer incredibly life threatening. While it is true that mumps and rubella are generally harmless long-term, although complications can arise, the same cannot always be said of measles. Measles is an extremely contagious disease, and it is has been shown that a non-immunized individual cohabitating with an infected person has a 90% chance of catching the disease. Indeed, it is so contagious that Babbot, in his article in the *American Journal of Medical Science,* remarked that measles was once considered "as inevitable as death and taxes" (1). According to data gathered by the US Centers for Disease Control and Prevention (CDC), the number of cases reported per year prior to the vaccine's approval hovered around a staggering 500,000. In the years following the 1963 introduction of the vaccine, however, the number plummeted to less than 100,000 cases per year. In 1993, the number of measles infections in the U.S. was further reduced to just 312 (Koo 3). Clearly, the vaccine, along with the strict immunization policies of most schools, has had a dramatically positive impact on the prevalence of measles in the US. However, the most pertinent numbers supporting the vaccine's efficacy come from a study by Bloch, et al. in the journal *Pediatrics,* which estimates that the measles vaccination had the following benefits within its first ten years: "52.1 million cases were averted; 5,210 deaths…were prevented; and 17,370 cases of mental retardation…were averted" (530). To gain true insight into the harmful impact of measles and the dire need for strong vaccine coverage, however, one must examine the

data available for the rest of the world.

Worldwide, because many countries have been unable implement a comprehensive vaccination policy against measles, the number of deaths attributed to measles was 164,000 in 2008. Prior to the start of the World Health Organization's long-term efforts to ensure children in countries with poor healthcare receive this vaccination, which began in 2000, the number of global fatalities due to measles was nearly 750,000 per year.

Even this data overlooks a crucial component of what makes the measles vaccine so important, a concept colloquially known as "herd immunity." The idea is simple: the fewer people in a population who are able to catch a disease, the harder it is for the disease to spread. Consider a series of concentric circles. If the innermost circle represents the first affected individual in an outbreak, every successively larger circle represents the population of people in contact with those in the circles surrounding it. If no one is vaccinated, the disease spreads quickly and successively into each circle, jumping from the first to the second smallest to the third and so on, affecting a greater number of people every time it jumps from one population to the next. If, however, everyone in initial contact with the first contagious individual is vaccinated, the disease cannot spread beyond the first inner circle and is effectively contained.

Thus, herd immunity limits how quickly and effectively a virus can spread and ends up containing many outbreaks before they even begin. The fact that herd immunity can stop the spread of a virus in its tracks is essential to the protection of our population as a whole, but, more importantly, it can prevent the spread of a virus to those who cannot be vaccinated. The list of people who cannot be safely be vaccinated includes newborns (who are also most apt to die of complications due to measles), those with compromised immune systems (such as those suffering from AIDS), and people who are allergic to one or more components of the vaccination.

One can see that the true efficacy of the MMR vaccine, then, lies in the number of people that can be convinced to have themselves immunized. Protecting those who are medically unable to help themselves is the most important reason to ensure high vaccine coverage, and it is the best way to ensure that the vaccine continues to be as effective as it has been in the past.

The Anti-MMR Movement's Claims

Much public outcry followed the 1998 publication of Wakefield's study claiming to have found a correlation between the increase in incidences of autism and the combined MMR vaccine. Many activists and parents were of the opinion that their children's mental disorders were caused by the vaccine, and presently the web is inundated with sites run and edited by medical laymen that purportedly explain how the vaccine causes autism. Of the many reasons put forth, the two most common are the use of the mercury-containing preservative thimerosal and a theorized interaction between all three viral components of the vaccine that somehow makes the vaccine toxic.

The least plausible of these claims of the anti-MMR movement is that the mercury-containing preservative is somehow neurotoxic enough to cause brain damage in infants and, subsequently, autism. Even a cursory look at the safety data available for thimerosal should be enough to convince someone that it is not the cause of the increasing prevalence of autism. The most obvious supporting point is that thimerosal has been widely used in many vaccinations since the 1930s, while the increase in autism rates did not begin until the late 1980s. Thus, to believe that thimerosal is the causative agent is to also accept a 50 year latency period before it began showing negative effects. Are today's infants somehow different than those born in the preceding 50 years? While it may be plausible that there are new environmental factors today

that were not present in the 1930s, it would be foolhardy at best to posit that it is the specific combination of these new environmental influences and thimerosal that is now causing autism rather than just the new environmental factors themselves.

In addition to this logical point, there have been many rigorous scientific studies demonstrating the safety of the use of thimerosal as a preservative, and one of the most recent was conducted by the CDC in 2010 and published in the journal *Pediatrics*. A summary released by the CDC stated that, "exposure to…thimerosal-containing immunizations during pregnancy (prenatally), or as a young child, was **not** associated with" any increased risk of autism ("CDC Study"). While the use of thimerosal in vaccines has been largely phased out by manufacturers, except in seasonal flu vaccinations, this should not be considered as an indication that the medical community is simply trying to cover up a mistake.

The second explanation put forth by the anti-MMR community is, admittedly, not so easily debunked without conducting statistical studies that can unequivocally disprove a causal relationship between the multi-virus inoculation and autism. As stated above, some speculate that the three different attenuated viruses in the vaccine interact with children's immune systems to cause autism, whereas the separate vaccinations for measles, mumps, and rubella, containing one virus type each, inexplicably do not. It is certainly difficult to track and analyze the interactions of a virus once it has entered the body, and significantly more so when the goal is find how three viruses might interact with each other and the body at the same time. The technology simply does not exist to easily form a clear picture of what might be happening *in vivo* with these three attenuated viruses, and, for this reason, the scientific community cannot simply reject the idea outright. That said, some simple understanding of fundamental biology illustrates that it would be very unlikely that these three viruses can interact with one another under those circumstances.

Viruses damage the body by inserting themselves into healthy cells and essentially tricking them into making more copies of the virus. Eventually, the formerly healthy cells become full to bursting with new virus particles and rupture, releasing new virus particles that go on to infect more cells. In order for a virus to find its way into a healthy cell, it uses a very specially shaped area on its surface to "dock" with a healthy cell's receptors and trick the cell into allowing passage. These very specific shapes are the keys that open the cellular locks. This lock and key concept is not just fundamental to viral replication, however; it is in fact how all of biology is known to work. Every protein and snippet of DNA in the body has a shape that is so specific that cells with incorrectly shaped keys are unable to meaningfully interact. The crucial point here is that all three viruses use different keys to gain passage into healthy cells, and that the body itself could not function if its various proteins were prone to interacting with molecules different than only their desired mates. Thus, because of the amazing interaction specificity of biological molecules, it seems highly unlikely that there is truly an interaction between the three components of the MMR vaccine *in vivo*.

Unfortunately, it would take an incredible amount of costly work and the development of new biochemical techniques to truly track and study the interactions of the MMR vaccine's components in the body. More useful as a refutation to the idea that the MMR vaccine causes autism would be case studies that show conclusively that the vaccine is not the cause of the increasing prevalence of autism. Fortunately, many such studies have been conducted.

The Safety of the MMR Vaccine

So the MMR vaccine protects us against some of the most virulent diseases in the world. While measles can produce deadly complications in children as well as those older than twenty,

rubella and the mumps are relatively benign, and most parents would not fret excessively if their children were to suddenly contract them. So if these diseases are fairly safe to contract, why would anyone vaccinate their children if it put them at risk for autism, a decidedly more serious disease?

The answer, put most plainly, is that there is no risk of a child developing autism as a consequence of receiving these demonstrably helpful and potentially lifesaving vaccines. There have been a preponderance of studies published after Andrew Wakefield's that used much larger sample sizes and sounder statistical practices that have found opposite results. More importantly, though, it can be shown that Wakefield overlooked important points during his analysis, and, in addition, there is one study in particular that indisputably shows that the MMR vaccine cannot be behind the increasing prevalence of autism.

The Wakefield study based its presumption that autism is caused by administration of the MMR vaccine on the observation of a steady rise in the prevalence of autism in the late 1980s, which roughly coincides with the time that the combined MMR vaccine became available and mandatory in many areas (the separated measles, mumps, and rubella vaccines, which did not differ greatly in composition from the combined one, were previously administered). However, Wakefield's study did not bother to take into account that the rise in autism's prevalence had already begun before the combined MMR vaccine was released (Gillberg, et al.). The earliest research noting that the rise in autism occurred before the MMR vaccine's release was published a full seven years before Wakefield published his findings. There was no excuse for Wakefield to have ignored that the increase in the autism rate did not truly coincide with the MMR release. Furthermore, it was noted that the rate of autism's increase did not accelerate after the

introduction of the vaccine, as would be expected if there was a causal relationship between the two.

Perturbed by these holes in Wakefield's study, Honda et al. set out to study the effects of withholding the MMR vaccine in populations where there had been a statistical rise in the autism rate. They argued that the true test of a causal relationship between autism and the vaccine would come from observing a population that had shown a steadily increasing occurrence of autism at the same time that the vaccine was being removed from the general population. They found the perfect circumstances for just such a case study in the Kohoku Ward area of Yokoama, Japan. Here, the incidence rate of Autism Spectral Disorders, a collection of symptoms known colloquially as autism, increased dramatically from 47.6 to 117 occurrences per 10,000 between the years 1988 and 1996. Tellingly, in 1988 the rate of administration of the MMR vaccination was 69.8%, and by 1993 it fell to 1.8%. After 1993, not a single dose of the combined MMR vaccine was administered to anyone. Despite the dramatic decrease in the number of people who were given the vaccine, the autism rate climbed as steadily as it did in every other developed nation.

This study clearly demonstrates that there is no causal relationship between the MMR vaccine and autism. If the combined MMR vaccine did indeed cause autism, the incidence rate of the disease would have declined steadily through 1993 as the vaccine's administration rate fell to zero, and thereafter should have dropped to levels comparable to what they were before the 1988 introduction of the combined vaccine—but none of these results were observed. Furthermore, Gillberg's work documenting the rise in autism before the introduction of the MMR vaccine also allows one to quite convincingly conclude that the introduction of the inoculation did not cause occurrences of the disease to increase. In addition, it is also worth mentioning that *The Lancet*

has since retracted Andrew Wakefield's study, his medical license has been revoked, and, upon further review of his published findings, another British medical journal came to the conclusion that he "misrepresented or altered the medical histories of all 12 of the patients whose cases formed the basis of the 1998 study—and that there was 'no doubt' Wakefield was responsible" (CNN Wire Staff).

Reasons for Continued Vaccine Refusal

This leaves medical professionals and educated onlookers alike with quite an anomaly: if it has been shown so concretely that the MMR vaccine does not cause autism, why would anyone risk children's safety by not having them vaccinated against measles, mumps, and rubella—particularly when measles can be incredibly dangerous for children?

The obvious answer, it seemed to me at first, lies within the heavy media coverage granted to the anti-MMR campaign after it came to be championed by celebrities like Jenny McCarthy. News outlets around the country were all too eager to grant Ms. McCarthy all the air time she wanted to plead her case—she claimed that her young child was stricken by autism on account of the MMR vaccine—knowing that a sympathetic mother's cries for help would be sure to boost ratings. The media's responsibility has been considered by those in the medical profession as well, and an article in the journal *Vaccine* discussing the MMR debate noted that, "Popular Media responds to drama, whether in the form of victims of vaccines or epidemics. It serves to reduce the complex … arguments to … human interest stories," (Baker qtd. in Burgess et al. 3926).

However convenient it may be to blame the media for giving the illusion that the medical community was divided about the consequences of the MMR vaccine (which it was not), the data

simply does not support this point. A study published in *Pediatrics* points out that, at least in America, where MMR coverage declined the least in response to the controversy, vaccination rates largely "rebounded…even with widespread coverage in the mainstream media" ("Media Coverage of Alleged"). It seems that those parents who still refuse to accept the MMR vaccine even 13 years after the scandal are not products of media persuasion. Nor can it be claimed they are uninformed, as pediatricians are held responsible for informing parents and always know when a child under their care goes unvaccinated. This suggests that there is something deeper going on with those who still balk at the inoculation.

I believe the reason for continued MMR vaccine refusal can be found by analyzing psychological research into how people make decisions involving small chances and inherently emotional outcomes. One experiment in particular conducted by Rottenstreich and Hsee illustrates beautifully how fear and other negative emotions can affect decision making. Hsee proposed a hypothetical decision that had two choices and four outcomes of differing probability to test subjects. The exact nature of the individual choices is not important; the key feature of the experiment was the potential outcomes of each decision. In this experiment, participants had the potential to win a small cash prize if they chose correctly, and each of the two choices had the potential to pay the cash prize.

"Correct" choices and "incorrect" ones were chosen at random, so the chance of winning the cash prize with either decision was the same. The only real difference between each decision was the exact nature of the negative outcome. For choice one, the penalty was simply monetary, and the contestant would have to pay the amount of the cash prize that he had hoped to win out of his own pocket. For the second of the two choices, however, the penalty was a very short but painful electric shock.

So the researchers set up the experiment such that a subject could chose choice one or choice two, both having equal potential to pay the cash prize and equal potential for the subject to suffer the negative consequence of either a cash penalty (choice one) or an electric shock (choice two). The remarkable thing that Hsee found was that people's preference for the electric shock or the cash penalty changed remarkably based on the perceived odds of suffering the penalty versus winning the cash prize. When they first conducted the experiment, they told subjects that there was a very high probability of suffering the negative consequence of their decision, which they called the "certainty condition." Under the certainty condition, subjects were largely apathetic to which penalty they received, and they chose between choice one and choice two nearly equal amounts of the time. It seemed under the certainty condition that subjects wanted equally to avoid the cash penalty and avoid the electric shock, as might be expected. Neither penalty is particularly troublesome, the experimenters argued, although in their view the subjects should have been fearful of the electric shock more than the cash penalty.

They next investigated what happens to subjects' decisions when they remove the certainty condition. In this experiment, subjects were told that there was a very high chance of receiving the cash prize no matter what decision they made, and that the chance of receiving the penalty was only five percent. This time the outcome of the experiment changed dramatically, and subjects chose the option that could only lead to the cash penalty seven times more often than they chose to possibly suffer the electric shock.

Hsee and his colleagues found the results they were looking for. They had previously hypothesized that when faced with a small likelihood of suffering negative consequences, people would overwhelmingly choose the path that had no chance of delivering the emotionally negative or frightening outcome. In the experiment, the electric shock was considered to be a

feared and emotionally traumatic outcome, whereas a cash penalty did not evoke these negative emotions of fear and dread.

One can easily see how this study applies directly to the MMR controversy, and it elegantly explains why some people are still so averse to vaccinating their children. The two decisions in this case are either vaccinating or not vaccinating a child, and parents believe that whatever decision they make, there is still a high likelihood of nothing happening to their kid. Because most new parents have never seen measles, mumps, or rubella, they feel that the odds of their child catching them are very low whether they are immunized or not. At the same time, they have heard that the MMR vaccine only causes autism in a small percentage of children who are vaccinated. This situation leads to two different choices, both of which have a small likelihood of anything bad happening, and a high likelihood that their children will be just fine. As shown by Hsee, this is exactly the condition where fear and dread set in to influence a person's decision much more than it should.

One negative consequence does not bring up the same negative emotions that the other does. The average person has heard that while measles, mumps, and rubella are certainly not enjoyable, neither are they debilitating or life threatening. Autism, on the other hand, has an incredibly emotional stigma because it has the potential to essentially cripple a child for life. It is no wonder, then, that some parents still choose not to vaccinate their kids. In their minds, it is a simple choice between an outcome that they fear and an outcome that they do not.

Potential Solutions

Equipped with an understanding of how and why parents make the ill-informed decision to not vaccinate their kids against measles, mumps, and rubella, it is now possible to understand

how to put forth potentially effective solutions. The heart of the problem is that parents do not see any highly emotional consequences to not vaccinating their kids, and this fact can be easily manipulated. Some doctors have suggested that making non-vaccination seem to have an equally horrifying consequence would force a lot of parents to reconsider. To this end, it has been suggested to use "visual images and stories of those affected to jog the community memory of the effects of diseases like polio," or, in this case, measles, mumps, and rubella (Leask and McIntyre 4703). I believe an equally effective and less uncouth way of doing this is by simply pointing out that the concept of herd immunity makes it a community, rather than individual, decision, and that their unvaccinated child could be the one who gives their friend's newborn measles. Simply pointing out to parents the responsibility that the unvaccinated have for spreading potentially deadly illnesses should be enough to invoke some powerful feelings of guilt, and may serve to offset the powerful effect that the fear of autism has on their decision making.

Final Thoughts:

In an age where vaccines have made possible the complete eradication of many once-frightening diseases, it is easy for us to forget that there are still illnesses lurking in the world that have potential to cause great harm. Following Wakefield's claims of the link between the MMR vaccine and autism, many parents have chosen to make the poor decision to allow their own children to go unvaccinated. Some are simply unaware of the danger that they pose to society as a whole by this line of thinking. Others, even when confronted with the scientific facts, still refuse vaccinations out of a simple desire to avoid giving their kids a crippling disease. While this thinking is understandable, it nonetheless represents a dangerous path because vaccine

efficacy is based in large part on the immunity of most of the individuals in a population. To combat this problem, it will be necessary to convince those parents who still believe in the MMR and autism link that non-vaccination can have equally dire and tragic consequences.

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