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COMMENTARY

Vaccine hesitancy: More than a movement

David Callender

School of Public Health and Health Sciences, University of Massachusetts Amherst, Amherst, MA, USA

ABSTRACT

Vaccines are some of if not the most successful public health endeavors ever put into practice. Countless lives have been saved and the occurrences of vaccine preventable diseases are at a fraction of the rate experienced before vaccines. Vaccines and the realization of their compulsory scheduling are highly studied, safe, and purposeful. Despite these realities, there are an alarming number of parents who do not permit the vaccination of their children as scheduled. This is known in the health community as vaccine hesitancy and commonly portrayed in popular media as anti-vaccination sediment. This analysis opens with the topic as it was addressed during a September 2015 debate for the Republic Party's 2016 presidential nomination. Some key historical aspects of vaccine hesitancy are presented. This history leads to a description of the 2014–2015 measles outbreak in California. The factors that aide in the recruitment of under vaccination are then explored. Finally, select strategies to control, combat, and potentially attenuate vaccine hesitancy are presented.

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Debating vaccines

On September 16th, 2015 the second debate for the Republican Party's 2016 presidential nomination was held at the Ronald Reagan Presidential Library in Simi Valley, California. Many in the national audience may not have known that Simi Valley is located only 70 miles from Disneyland Park, the site of a 2014–2015 anti-vaccine linked measles outbreak. Of the 11 Republic candidates involved in the debate, Public Health took center stage for three. These three included one outspoken real-estate tycoon and presidential nomination frontrunner, Donald Trump. Dr. Ben Carson, the second, is a retired pediatric neurosurgeon well known for his "Gifted Hands" as the first to successfully separate cranially joined twins. The third, is a retired ophthalmologist and Kentucky Senator, Dr. Rand Paul. CNN's anchor, Jack Taper, provided the 3 candidates with beach ball caliber questions that were ready to be spiked to the ground in favor for Public Health by the 2 Doctors. Unfortunately, Public Health did not fare so well at the expense of anti-vaccination sediment.

Donald Trump, with his well-known stance advocating for the harms of vaccines, was supposed to be on the losing end of this minor skirmish.[1] Dr. Ben Carson has completed years of pediatric and surgical training. His medical training includes a robust professional knowledge of pediatric vaccination policies. He was expected to easily defend pediatric vaccinations and dissolve Mr. Trump's stance before it had a chance to consume airtime. Jack Tamper asked,

> *"Dr. Carson, Donald Trump has publicly and repeatedly linked vaccines, childhood vaccines, to autism, which, as you know, the medical community adamantly disputes. You're a pediatric neurosurgeon. Should Mr. Trump stop saying this?"*

Dr. Carson was far from strong in his response by saying only,

> *"There have been numerous studies, and they have not demonstrated that there is any correlation between vaccinations and autism."*

A strong, uniformed, and absolute response should have followed. Nonetheless, it did not. This allowed Mr. Trump to provide information to the national public that is not supported by the medical and scientific communities.[2] With the lack of a conquering response from Dr. Carson and Dr. Paul, Mr. Trump was able to open with,

> *"Autism has become an epidemic. Twenty-five years ago, 35 y ago, you look at the statistics, not even close. It has gotten totally out of control."*

After implying that he opted for a protracted or alternative vaccination schedule for his children, he went on to say,

> *"Same exact amount, but you take this little beautiful baby, and you pump - I mean, it looks just like it's meant for a horse, not for a child, and we've had so many instances, people that work for me."*

Mr. Trump then told a story of a toddler who had been diagnosed as autistic just a week after getting a vaccination. Dr. Carson, briefly confirmed that there was no link between autism and vaccinations but spent more time discussing an alternative vaccination schedule. Specifically, he says,

> *"We are probably giving way too many in too short of a period of time…cutting down on the number and the proximity in which those are done."*

Unfortunately, Dr. Carson did not take the opportunity to emphasize that alternative vaccination schedules are potentially harmful.[3] Furthermore, he failed to mention that vaccines and the realization of their compulsory scheduling are highly studied, safe, and purposeful.[4] Dr. Carson ended the discussion by saying,

CONTACT Dr. David Callender, MD dcallender@umass.edu School of Public Health and Health Sciences, University of Massachusetts Amherst, MA 01003, USA.

"You know, a lot of this is pushed by big government."

Though a missed opportunity to laud the success of Public Health on a national stage, this debate shed interesting light on the persistency of the anti-vaccination movement.

Introduction

Vaccines and their implementations are some of if not the most successful public health endeavors ever put into practice.[5] Countless lives have been saved and the occurrences of vaccine preventable diseases are at a fraction of the rate experienced before vaccines. Researchers can extrapolate, from vaccines given today, a lifetime of individual and societal savings. Specifically, the schedule of pediatric vaccines given to a hypothetical cohort of 4 million children born in 2009 will prevent approximately 20 million illnesses and 42 thousand deaths over that cohort's lifetime. Controlling for inflation, the vaccines given to that cohort are associated with savings of $14 billion in direct costs, and $69 billion in indirect costs.[6] Despite these facts and figure there are an alarming number of parents who do not permit the vaccination of their children as scheduled. This is known in the medical community as vaccine hesitancy and commonly portrayed in popular media as anti-vaccination sediment. These terms are used interchangeably throughout this paper. More specifically, vaccine hesitancy has a continuum of manifestation ranging from outright refusal to delays in administration to fleeting questions about a particular vaccine. This paper will focus on the more extreme stances which have the potential for the highest degree of harm. We will begin by reviewing important aspects of the history of vaccines. This history will culminate with a description of the recent measles outbreak in California. We will then explore the factors that aide in the recruitment of under vaccination. Finally, we will delve into a few select strategies to control, combat, and potential attenuate vaccine hesitancy.

Historical components of vaccines and their hesitancy

Since antiquity, astute medical scholars have noticed that some diseases do not reoccur in a previously afflicted individual. These quasi-researchers performed surreptitious experiments by intentionally inoculating others with infected byproducts. By initial happenstance and fueled by further scholarly inquisitions knowledge was slowly acquired. In China, scabs from particularly mild cases of smallpox were desiccated and pulverized. The resulting powdered material was subsequently inhaled. As this practice of variolization lacked standardization and a detailed understanding, it provided variable levels of protection from future infection with smallpox. Promising and helpful to many, this practice eventual spread across the silk road. Specifically, diplomats such as Lady Mary Wortley Montague returned to Britain from Turkey with her variolized children.[7] This allowed the practice to eventual gain footing in Europe. Variolization was neither safe or immune from speculation. Poorly qualified practitioners could mistake a donor's actual chickenpox lesions as smallpox lesions. Furthermore, recipients of this practice could be infected with other pathogens during the procedure. Additionally, nefarious people sought to both monopolize and profit from the practice by falsely advocating for excessively deep cuts and extreme bloodletting. This was in fact a very dangerous practice. Yet, countless deaths were prevented long before the theory of germs and immunological processes were understood.

By the late 1700s, Dr. Edward Jenner and others loosely understood that a less virulent disease such as cowpox could prevent someone from a recalcitrant disease such as smallpox. He and his contemporaries hypothesized this after they noted that milkmaids very rarely if ever suffered from smallpox. In 1796, Dr. Jenner, took material from his milkmaid's, Sara Nelms, fresh cowpox lesions. He then inoculated his gardner's 8-year-old son, James Phipps, with the material. Dr. Jenner later challenged James directly with smallpox pustules and the young boy never developed smallpox. His experiments were met with much skepticism. The results took years to garner validity and provide for the supplanting of variolization in England and Europue.[8]

The United States was slower in its implementation of vaccinations. It required a few particularly vigorous smallpox outbreaks through the 1800s for vaccinations to gain fervor. Interestingly, the state of Massachusetts was at the forefront of new policy development. In 1902, a smallpox outbreak caused the board of health in Cambridge, Massachusetts to mandate all residents be vaccinated against smallpox. A forceful resident, Henning Jacobson, refused to abide by the mandate. He believed that the law did not allow him to fully exercise his freedoms through choosing what was best for his body. Despite no ability to enforce the mandate, aside from a $5.00 fine, a lengthy court battle followed. Cambridge filed suit against Mr. Jacobson and in 1905 the Supreme Court ruled that a municipality or state could enact a law to protect the public against a disease.[9] Smallpox has since been eradicated from both the developed and undeveloped world as a true marvel of modern medicine and vaccinations.

With the success of the smallpox vaccination, other scientifically validated and purposeful vaccinations have been implemented in the United States. With each of these vaccines controversies followed which for the most part is too expansive for the length of this paper. Of particular interest in relationship to points broached in the introductory debate, is the late 1990s and early 2000s controversy between autism and the Measles, Mumps, and Rubella (MMR) vaccine. A British physician, Dr. Andrew Wakefield, published a sentinel paper linking the MMR vaccine with both inflammatory bowel disease and autism.[10] His theory was that the live, though attenuated, measles vaccine reacted with the intestines to allow toxic, autism causing, substances to enter the blood stream and brain. This paper was published in one of the most prominent medical journals, The Lancet, and immediately drew public media attention. Dr. Wakefield was subsequently charged with medical fraud, faulty research, and his monumental findings have been discredited universally by the medical and scientific communities. As the general public does not obtain information from medical and scientific journals, the record has continued to need straightening. Public figures from entertainment Jenny McCarthy and Jim Carrey to presidential candidate Donald Trump have continued to place seeds of doubt supporting Dr. Wakefield's evidence-resistant theory.[11]

Implications of vaccine hesitancy: Measles

Vaccine hesitancy is particularly damning to highly transmissible diseases such as measles. This is due to the fact that a population's rate of immunization must remain high to prevent an outbreak. The measles vaccine is very effective and just one dose can prevent infection in 99% of individuals. With advanced analytics scientists have determined that approximately 90% of a population must be vaccinated against measles to prevent an outbreak.[12] Not everyone in a population can be vaccinated and some depend on the herd of those vaccinated for protection. Herd immunity is essential for those who are too young to be vaccinated, are allergic to components of vaccines, or do not have the reserve to mount immunity through vaccines (cancer, immunosuppression). It is therefore essential that nearly all of those medically eligible for vaccines receive them.

One setting that has been indispensable for vaccines are schools and their mandatory school immunization programs. School vaccines have been variably compulsory since a Supreme Court ruling upholding their constitutionality in 1922.[13] The last 20 y have seen a propensity for non-medical exemptions due to philosophical and/or personal beliefs. Though rare, an alarming 1–2% of parents refuse all vaccinations for personal reasons. From 2004–2011, the average rate of non-medical exemption per state rose from 1.48% to 2.2%.[14] Even more concerning is that vaccination refusals are much higher at the community level and tend to cluster. Prior to recent law changes, a few counties in Washington state and school districts in California saw a rapid increase in non-medical exemptions. In fact, exempted children in some localities soared to rates above 20%.[15-16] Clusters of Californian vaccination refusals have been fueled by an individualistic society eager for the novel chic as exemplified by "Dr. Bob's" alternative vaccine schedule titled, "The Vaccine Book: Making the right Decision for your Child."[3] Medically unfound novels such as this coupled with a very non-intrusive application process, led California's personal belief exemptions to increase 380% from 1996 to 2010. In the early 2010s California tried to make the exemption more cumbersome by removing a pre-printed affidavit from immunization paperwork and requiring a physician's signature attesting to having provided counseling. Unfortunately, this was too little too late. Despite, such actions California still saw a doubling of non-medical exemptions from 2007–2014. Aforementioned and by 2014, many communities had over 20% of children without adequate vaccinations. The conditions had been set for an inevitable vaccine preventable disease outbreak.[17] In January 2015, cases of measles began to be reported in unvaccinated children with a common travel history to Disneyland during the previous Holiday season. By February, 125 measles cases had been reported of which 110 were California residents. The majority of cases in California residents were either unvaccinated due to noncompliance or a personal belief exemption.[18] In June 2015, California signed into law Senate Bill 277 joining West Virginia and Mississippi as the only states that do not allow philosophical (personal or religious) exemptions. As can be easily conjectured from the events that transpired in California, there is a complex relationship among societal networks, individual liberties, and the ultimate eroding of our public's immunity to vaccine preventable diseases. These relationships require further discussion.

Factors aiding in the recruitment of vaccine hesitancy

There are extensive cognitive, cultural, and social factors that aide in the recruitment of under vaccination. To view vaccinations with hesitancy is not a matter of Everett Roger's well studied and widely applied product adoption lifecycle schematic of innovators, early adopters, early majority, late majority, and laggers.[19] Those who are hesitant to vaccinations, which have been lauded for years, decades, and even centuries, fall outside this adoption lifecycle. They are very statistically significant outliers. In fact, these outliers have their own continuum. Decision making about vaccinations lies on a hesitancy continuum from outright refusal to steadfast acceptance. The heaviest of resisters are the outright rejecters of vaccinations. These individuals are unimmunized, have high safety concerns, and lack trust in medical providers.

What causes an individual to assume such risk at the expense of such benefit to self and society? The first place to examine are the potential concerns with vaccines themselves. Parents may overemphasize the immediate side effects of a vaccine, be it rash, swelling, or pain. They then justify these side effects as a valid rationale to avoid vaccination. This is a very attenuated level of hesitancy but can be a gateway to under-immunization, delays, and further questioning. A more steadfast level of hesitancy deals with that perceived long-lasting effects of immunization. Despite extensive medical literature to the contrary, parents continue to demonstrate concern that the MMR and in particular measles vaccination component is associated with autism. Concern regarding the influenza vaccination and a recalcitrant ascending paralysis, Guillian-Barre syndrome, also remains a concern despite the current formulation of the vaccine has never been shown to have this association. These two concerns are rooted in the cognitive fallacy of omission bias.[20] This bias allows one to overemphasize the risks of doing something and minimize the risks of not doing something. Some other common concerns center on the number of vaccines currently mandated. In particular, the aspects relating to the short interval between doses, simultaneous administration, immune system intolerance, and the proposed hasty approval of newer vaccines.[21] These concerns are logically valid from an intellectual perspective. However, they are not supported by medical research. This brings to light the general public's crude knowledge of vaccine development and safety monitoring. One further vaccine specific concern is that the success of vaccination endeavors has led to generations of decreased exposure. The collective knowledge of disease implication profiles has been lost with the success of vaccines. Due to lack of first, second, or third hand experience with vaccine preventable diseases there is now an underestimation of complications associated with vaccine preventable diseases. This paucity of collective knowledge in itself can tip the scales in favor for vaccine hesitancy when in fact the risks of vaccination do not at all outweigh their benefits.

The next facets to examine are at the individual level. These are clustered by race, education, and socioeconomic backgrounds. Parents of the lowest income brackets and education

level report greater concern regarding the need for and the unwanted effects of vaccines.[22] This same group, which is unable to synthesis and apply high quality medical literature, has traditionally been less trustful of the medical community. They are more likely to latch onto outlying information that is reported by unrepeatable sources such as by celebrities or through social media. With the advent of Web 2.0 (Facebook, Twitter, Reddit, etc) individuals are able to share their experiences be them true or false. Analysis of YouTube vaccination videos shows that 32% oppose vaccines. Nearly half of the oppositional videos provided information that contradicted reference standards. This is particularly concerning as the internet now rivals physicians with respect to medical clout. The data now shows that 16% of people look for vaccine information online and 70% use what they found to guide their medical care.[23] Optionally forces are successful because vaccine-hesitancy website have a common internal operating picture. Most of their arguments can be grouped into the "denialistic" viewpoint. Denialism is defined as the use of arguments heavy in rhetoric that give the appearance of legitimacy but only really wish to reject the scientific consensus. They solely seek supporting information, dismiss other information, use logical fallacies, and lean heavily on false expertise. The same reference above[23] noted that just using these websites is correlated with increased proposed risk of vaccines and a propensity for vaccine hesitance.

Ways to combat vaccine hesitancy

Now that we understand a little more about why people may choose not to vaccinate, we can look at ways to combat this. First, we need to continue to provide grants to promote for the highest caliber of medical research regarding the adverse effects of vaccinations. In this realm we also need to be vigilant in our reporting of adverse events and have input mechanisms that are both user friendly and comprehensive. This coupled with continued outright forthcoming of all findings will provide legitimacy to our data hungry society. I believe that medical providers must always be at the forefront of the battle against vaccine hesitancy. Medical providers should be educated on how to counter arguments against vaccines at a level that patients will understand. There is clearly a disconnect. Researchers have performed a systematic review of the safety of vaccines used for children in the United States.[24] This review found no risks of autism. In fact it found only rare and minor risks associated with other vaccines such as self-limiting and fully resolvable febrile seizures (MMR, Influenza, Pneumococcal), allergic reactions (Meningococcal, Polio, Hepatitis B), and bruising (Hepatitis A). No medical treatment is free from danger and this risk profile is very benign. Information such as this needs to be repeated to general public and medical providers are the most apt to see this to fruition.

Fortunately, the risk of morbidity and mortality from the current generation of vaccine preventable diseases is much lower than centuries ago. Unfortunately, this allows a kindling of vaccine hesitancy to repeatedly catch fire without as much attention as it should. It is difficulty to combat these concerns when figures at the forefront of our society, as outlined in the introduction, recapitulate these sediments. It is important to look at the history of both the success of and hesitancy toward vaccines through the years. From this one can predict events as demonstrated by the Disneyland outbreak of 2014–2015. Ultimately, our society must better understand the reasons leading to vaccine hesitancy before we can appropriately combat these hesitancies. There needs to be a unified message from medical providers, popular figures, and public figures. This message must be geared toward parents fears as well as their desires. Policy makers and medical providers need to understand that parents are ultimately trying to do what they feel is best for their children. Successful interventions must include a confiding and emotionally connected relationship where genuine trust is garnered.

Conclusion

A perfect example of a forward thinking unified approach between medical professionals and cultural figures was aired in February 2015 on the Jimmy Kimmel Show and as of March 23, 2016 has been viewed by 6,473,584 people.[25] Reading through the 15,179 comments helps to shed light on how contentious this topic remains to this day. As so comically stated by one medical doctor during this 5-minute skit, "Hey remember that time you got polio, no you don't, because your parents vaccinated you!." Humor is often a great connector and can be an important clinical tool to bridge the often unheard sediment that "The cumulative scientific and medical communities are in absolute full agreement" and "get your kids vaccinated!."

Abbreviation

MMR Measles, Mumps, and Rubella

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