



Research Article

Vaccinations and the Influence of Social Media in the United States

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Abstract

This paper aims to explain the importance of vaccinations and offer a critical analysis of how the anti-vaccine campaign has made traction through social media. The anti-vaccine movement has thrived on social media platforms as groups of parents, religious groups, and celebrities continue to attack vaccines for their perceived medical flaws and harmful side effects. Many studies have shown that parental decisions to use or avoid immunization for their children are complex and multi-dimensional. These include contextual determinants, determinants related to the vaccination services and individual determinants, such as parents' knowledge, attitudes and beliefs or sociodemographic characteristics. With public information drifting towards the hesitant viewpoint, many well-intentioned parents are confused as what to believe when vaccinating their children. The child vaccination percentage has decreased in the last two decades. The anti-vaccine movement has done an adequate job in using social media to build its following and spread its message of perceived unsafety, including correlations to autism. However, the pro-vaccine supporters and federal institutions have not used social media as adequately, often ridiculing those who oppose their medically based views and deter parents who are in limbo of vaccinating their children. This study, while analyzing social media's influence on the vaccine controversy, recommends strategies to promote pro-vaccine information on social media and regulate responses for addressing anti-vaccination media.

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Introduction

The number of unvaccinated children has quadrupled since 2001, as parents have become increasingly hesitant about vaccinating their children [1]. This laissez-faire attitude towards vaccinations drives what is known as vaccine hesitancy. Vaccine hesitancy can be described as the resistance or refusal of vaccines when vaccines are readily available. It encompasses the decision making process of not vaccinating dependents or oneself. The World Health Organization designated vaccine hesitancy as a top 10 global health threat in 2019 [2]. It has become so much of a threat that the United States is at risk to "lose its World Health Organization designation as a country that has eliminated measles because of outbreaks this year", according to the director of the Centers for Disease Control and Prevention (CDC) [3]. Measles was declared eradicated in the US in 2000, which at the time was seen as one of the greatest achievements in public health. A loss of eradication status has greater implications globally. The US has publicly encouraged other developed and developing nations to vaccinate when vaccines are available, yet, is unable to maintain immunity domestically. Losing the eradication status puts the United States public at greater health risks. This highlights the decline in concern for the danger of these vaccine-preventable diseases. It has been said that vaccines have been a victim of their own success, where many individuals have forgotten the dangers of vaccine-preventable diseases. Many parents and children of this era have not been exposed to these dangerous diseases, largely because of the success of vaccinations. For example, while CDC advisor, William Schaffer, was delivering a speech about polio, he was questioned about the disease because a parent had mistakenly thought the disease to be the common shirt brand "POLO" [4]. While this might be an extraordinary case, it goes to show how removed from infectious diseases we have become as a society.

Diseases such as measles, mumps, pertussis and influenza all have vaccinations readily available in the United States; however, many Americans are fear stricken by vaccinations because of the misconceptions that relate to the immunization. Social media has been used as a tool to label vaccines as harmful, keeping many well-intentioned parents from vaccinating their children. Anti-vaxxers are individuals who openly refuse receiving vaccinations for themselves or their dependent. They commonly fear that vaccines are dangerous, despite scientific discoveries. To them, spontaneous media and social misconceptions can hold more power than scientific data. As they grow in numbers, what has been known as the Anti-Vaxx movement continues to misguide and misinform well-intentioned parents on the internet. Their decision to not vaccinate comes from a multitude of different factors, most of which can be stimulated by social media influences that claim false facts about the success of vaccines. The World Health Organization identified three factors that commonly contribute to vaccine hesitancy: Complacency, confidence and convenience [5]. Social media can influence reservations in all three of these categories. Complacency around immunizations can be driven by the concept of herd immunity. Herd immunity is a concept that suggests

when a sufficient portion of a population is immune to an infectious disease, the outstanding population who has not developed immunity remain protected. While it is an effective concept in theory, for herd immunity to be effective in reality, at least 95 percent of the population must be immune. The Centers for Disease Control and Prevention found that the vaccination rate for Measles, Mumps and Rubella (MMR) immunization in kindergartners in the 2017-2018 school year had slipped nationally to 94.3 percent” and for the third year in a row it has continued to decrease [3]. Parents who spend much more time on social media than they do consulting with their physician or pediatrician about vaccinations have switched to a more individualistic style of parenting. This style is precisely why herd immunity loses its effect. Parents make what they believe to be protective decisions for their child, rather than acting altruistically. In reality, the concept of herd immunity provides false security for anti-vaxxers and hesitant parents, especially when vaccination percentages are lower than 95 percent.

Anti-vaccine activists criticize the strength of immunizations on the internet and have influenced legislation. Several times since 2000, state legislatures have reversed or widened its position on vaccine exemptions, allowing more freedom in choosing to remain unimmunized. There are three legal exemptions to vaccinations that mandated by public schools and organizations. The three exemptions include medical, religious, and philosophical exemptions. Five states (West Virginia, Mississippi, California (since 2015), New York and Maine (effective Sept. 1, 2021) do not accept religious or philosophical exemptions, while the other 45 states accept medical and religious exemptions, or all three. West Virginia has the highest percentage of kindergarteners vaccinated at 98.4 %, while the District of Columbia, allowing all three exemptions and is of the lowest percentage of kindergarteners vaccinated at 81.3 % [3].

More recently, people are warned to view public information on social media platforms more cautiously. However, this was not always the case. In the early 2000's, as the internet was becoming more advanced, users were more likely to trust information because of the title of an author, even if the information was inaccurate. This behavior has still not been curbed, as populations are experiencing the effects of mistrusting scientific data for nearly 20 years. In fact, anti-vaccination movements can be traced to 1982, when NBC aired the documentary “DPT: Vaccine Roulette”, which took up a controversy in England. The documentary correlated pertussis vaccines and seizures in young children [6]. Pertussis, or whooping cough, is a potentially fatal disease that can lead to brain damage and respiratory complications. Doctors and infectious disease professionals criticized the documentary commenting that it “emphasized the risks of the vaccine while ignoring the dangers of the disease, which has been almost wiped out in [the UK]”, largely because of the vaccine [6]. Even when the documentary was discredited, vaccine hesitancy was inoculated into the public. Then, in 1998, Andrew Wakefield, a British gastroenterologist, published a study in the *Lancet* that associated the MMR vaccine with autism. The study has since been retracted and discredited, however hesitancy persisted. Parents were unwilling to have their child vaccinated because of the suspicion of their child developing autism. While measles was a disease that they have most likely never encountered before, it is easier to abstain from vaccinating. Later down the road, as social media platforms gain more traction and popularity, celebrities took to voicing their opinions on public issues, politics, and the vaccine controversy. In 2007, Jenny McCarthy, an actress, vocalized that vaccines caused her son's autism.

Many citizens found her to be more persuasive than scientific data from the CDC, which showed otherwise.

The Anti-Vaccination movement is becoming more prominent within the public because their approach on social media has been more active and convincing than pro-vaccine activists. “In recent years, we can encounter a growing modern anti-vaccination movement, which argues that the dangers of vaccinations far outweigh their benefits. Unlike the more religious groups that are primarily inwardly oriented, this new anti-vaccination movement actively and successfully reaches out to new parents through anti-vaccination websites and TV celebrities” [7]. While both religious groups and social media activists work to scrutinize the success of vaccinations, they each take a unique approach, one casting outward projections to the public and the other spreading in common communities. In this study, we will focus on the growing anti-vaccine community and how they have flourished through social media platforms, while communicating the medical, legal and ethical implications of the vaccine controversy.

Legal: Medical Exemptions

There are three potential exemptions that are mandated which one can use to opt out of vaccinating oneself, or their dependents, given their state of residence. An exemption is described by the CDC as a written form that includes the refusal of a dose of vaccine for their child, refusal of a specific vaccine series for their child, or the refusal of all vaccines for their child [8]. The exemptions are as follows:

Medical vaccination exemption

The first is medical vaccination exemption serves to protect those who, for medical reasons, cannot receive vaccinations. For example, the recipient may be too young or immunocompromised to receive the vaccination. All 50 states allow for medical exemptions. The majority of states mandate that a valid medical exemption must be written by a licensed physician. The written statement must include the medical condition of the patient, the vaccines being exempted and whether the exemption is temporary or permanent. Each vaccine series has its own medical exemption. Each medical exemption is given by a physician based on clinical evidence and evaluation of each patient, using their best clinical judgment. 5 states currently restrict vaccinations to medical exemptions, including West Virginia, Mississippi, California (since 2015), New York, and Maine (effective September 1, 2021).

Even though medical exemptions are quite specific, several issues can still arise. Some exemptions may be written without any basis of medical reasons that would prevent the child from receiving a vaccine. Philosophical and religious justifications seem to circumvent valid medical exemptions in states that only accept medical exemptions. In California, a state that eliminated nonmedical exemptions for public school entry, saw a 250 % increase in the amount of medical exemptions in the two school years after the Senate Bill 277 (SB277) was passed [9]. The SB277 was passed in 2015 to eliminate nonmedical vaccination exemptions for school entry. In response to the SB277, personal belief exemptions have decreased, but medical exemptions have increased. Counties that had a high rate of personal belief exemptions had the highest increase of medical exemptions during the first year of SB277 implementation [9]. This increase in medical exemptions comes from a physician compliance to write medical exemptions for people who “lack scientifically-justifiable contraindications”, who are seeking to circumvent laws that prohibit

personal belief exemptions [9]. The specific contraindications, most of which are temporary and allow the individual to receive the necessary immunizations in the future, are detailed by the ACIP (Advisory Committee on Immunization Practices).

Religious vaccination exemption

The second type of vaccination exemption is a religious exemption. Under the Constitution, American citizens have the right to religious freedom. A religious exemption is the refusal of a vaccination or all vaccinations on the basis of religious belief. However, a religious exemption to vaccinations must be defended. In order for a religious exemption to hold validity in public schools, the exemption must be to protect those who hold sincere religious beliefs, opposing vaccinations to the extent that if the state forced vaccinations by law, it would be an infringement of their constitutional right. Common religious groups that refuse vaccinations include the Orthodox Jewish community, some Muslim communities and the Dutch Reformed Church. The source of vaccine preventable virus outbreaks has been traced to unvaccinated travelers visiting Israel, where the disease is spreading, who then return to the US, spreading the disease domestically. Religious exemptions are intended to protect an individual's first amendment rights; however, the state can overrule religious exemptions with a "compelling State interest", validly defined as limiting the spread of serious infectious and communicable diseases [10]. As of now 45 states accept religious exemptions. The states that do not are West Virginia, Mississippi, California, New York and Maine (effective September 1, 2021).

Philosophical vaccination exemption

The third type of vaccination exemption is a philosophical, conscientious or personal belief exemption. This exemption can be used by individuals who hold conscientious objections to vaccinations. The British Vaccination Act of 1898 gave rise to the exemption that is widely based on popular personal objections. The guidelines for this type of exemption is quite vague; some states require a philosophical rejection to all vaccines, rather than just one, or a series, while others mandate parents to obtain a signature from a physician. There are 15 states allow for Philosophical exemptions, in fact they allow for all three exemptions. These states are Washington, Oregon, Idaho, North Dakota, Wisconsin, Michigan, Ohio, Pennsylvania, Louisiana, Arkansas, Oklahoma, Arizona, Utah, Texas and Colorado.

Philosophical exemptions are where the law surrenders its hold on maintaining public health. With personal belief exemptions, there is room to be misguided in the vaccine controversy, specifically forming misconceptions that vaccinations can do more harm than benefit. Allowing Philosophical exemptions to vaccinations endorses hesitancy for accepting and receiving vaccinations. Allowing for an exemption, defended by personal morals or values, implies that there is something inadvertently immoral about the scientific and medical nature of vaccines that moral individuals should object to. In reality, this is not an ambiguous message that the law should set for a susceptible audience, prone to believing false information on social media. Unpolished and vague defining of philosophical exemptions hold individuals from lifesaving vaccinations based on misinformed and unsupported beliefs.

Although there is no federal regulation in mandating vaccinations, all 50 states legally require vaccination of children prior to school or

daycare entry. At the same time, this legal duty is accompanied by a system of exemptions [7]. The system for accommodating both state interests as well as individual beliefs within a liberal democracy is called rule-and-exemption. This is where a mandated rule can be in place, in this circumstances vaccination, where the majority of citizens comply with and also allow for exemptions for minority groups who object to the mandated laws. Those who remain unvaccinated for pose a viral threat to those who may temporarily be unable to receive vaccinations. Physicians need to be held responsible for providing evidence based healthcare to their patients, caring for them with their best judgment, while school districts and scholastic institutes need to be held responsible for enforcing the exemption laws. Silverman, a professor of health policy and management at Indiana University-Purdue University Indianapolis, affirms West Virginia's success maintaining high vaccine percentages, largely because of the narrow exemption process, and also because the state's public-health agencies have worked closely with the legislature [11]. A system must police the validity of medical exemptions to vaccinations, especially in states that do not allow for personal belief exemptions.

Medical Implications of Vaccines

Necessity of vaccinations

To understand the necessity of vaccinations, it is important to understand the scientific basis of vaccines. Vaccines provide artificial immunity in which memory cell production is stimulated allowing patients to produce a strong secondary response when exposed to pathogens without having to mount a primary response by being exposed to the infection itself. This concept is referred to as artificial active immunity and it is the basis of the mechanism of action of vaccines. Through artificial active immunity, adaptive immunity is activated by deliberately exposing a patient to inactivated or weakened pathogens that are unable to cause disease. Vaccines also work by activating either humoral or cell mediated immunity or both. Humoral immunity involves B cells that produce antibodies to fight extracellular antigens. Cellular immunity utilizes T cells that produce immune cells to fight intracellular antigens.

There are various types of vaccines which allow for the body to create this response. The first is a live attenuated vaccine in which a weakened pathogen produces a subclinical infection to activate both cellular and humoral immunity. The immune system will in turn produce memory cells to provide for lifelong immunity. As this type of vaccine does incorporate a weakened version of the pathogen, there is risk of the pathogen reverting to full virulence and producing disease, specifically in immunocompromised patients. However, precautions are taken in this scenario and the administration of live attenuated vaccines are limited to individuals who are not pregnant or immunocompromised, such as in those with HIV and CD4 counts <200 and cancer patients. Live attenuated vaccines include MMR, Varicella and Yellow fever.

Inactivated vaccines contain a whole pathogen that has been killed and inactivated while maintaining the structure of the pathogen's antigens. These vaccines activate humoral immunity only because they do not produce an active infection. One disadvantage of these inactivated vaccines is that they often require a series of booster immunizations to maintain immunity. The problem with vaccinations that need a series of boosters is that patients are less reliable in returning for scheduled vaccinations, and may think they are fully immune, but are not.

Examples of inactivated vaccines include hepatitis A, influenza, cholera, and rabies.

Subunit vaccinations expose an individual to only the key antigens of the pathogen, not the whole pathogen as in inactivated vaccines. For this reason, there is a relatively low risk of adverse effects; however they also require multiple doses. Subunit vaccinations include hepatitis B, meningitis, pneumococcal pneumonia, and whooping cough.

Conjugate vaccines enhance the effect of subunit vaccines by producing capsular polysaccharide antigens that produce antibodies which destroy capsules of pathogens that would otherwise allow them to avoid elimination via phagocytosis. Conjugate vaccines allow children under the age of 2 to mount a better response to subunit vaccines. Examples include *Haemophilus influenzae*, *Streptococcus pneumoniae*, *Neisseria meningitidis* as well as meningitis.

Lastly, toxoid vaccines contain only inactivated bacterial toxins which play an important role in producing disease. These toxins activate humoral immunity to neutralize the toxins. Vaccines include botulism, diphtheria, tetanus and pertussis [12].

The type of vaccine plays a role in determining the schedule of vaccine administration. Vaccine schedules are determined by The Advisory Committee on Immunization Practices (AICP) which consists of medical and public health experts. Information taken into account by AICP to determine immunization schedules include safety and effectiveness of vaccine when given at specific age, severity of disease, numbers of individuals who will get the disease if there is not a vaccine and the varying response to a vaccine based on age. Diseases are studied to determine at what age they are likely to peak, however in general vaccinations are given at the earliest time possible. The risk of being exposed to a disease is compared to the benefit of administering a vaccine at the optimal age to determine vaccination schedules [13].

Recent controversies surrounding vaccines have led to skepticism and a decreased rate of administration of vaccinations; however immunizations are an absolute necessity to preserve the health of individuals as well as entire communities. This need for vaccines is evident in the recent reemergence of nearly eradicated diseases, including measles. For example, in 2004 in the UK, the percentage of measles vaccinations had fallen to 80 %. In this same year, the number of cases of measles outbreak abruptly increased which in turn set back the effort to eliminate a nearly eradicated disease [14].

One reason why the rate of vaccinations has decreased is due to a lack of public education. Many view the risks of vaccination as outweighing the benefits. For example, false reports of vaccinations being linked to autism led to a new found uncertainty regarding whether a potential risk outweighs a guaranteed benefit with immunizations. As vaccinations have made the incidence of deadly diseases rare, it in turn has produced a perception that the risk of contracting the disease is low with or without vaccination [14]. Along with this miseducation, there is a general mistrust for pharmaceutical companies, including those that produce vaccines. Therefore, many believe that the incidence and risks of diseases are blown out of proportion by these companies in an effort to increase the rate of vaccination for their profit.

Another reason for decreased rates of immunizations is the concept of patient autonomy. Patient autonomy is the right of a patient to

make his or her own decisions regarding the medical care that he or she will receive without influence or coercion by a health care provider. This has become the basis for patient's ability to refuse vaccines, not only for themselves, but also for their dependents. According to The World Health Organization, the number of children who have not received vaccines has quadrupled in the past 17 years [15]. Currently, the only states that mandate a medical reason for exemptions to vaccinations are West Virginia, California and Mississippi [15]. However, along with the idea of patient autonomy is the oath a physician takes for beneficence and nonmaleficence, the ideas that a physician should act in the best interest of the health of a patient and avoid medical decisions that would do harm unto the patient. One can easily argue that by allowing patients to choose not to vaccinate, not only are they putting themselves at risk but also those around them who are unable to be vaccinated and future generations who will likely face a resurgence of rare diseases.

Despite the controversies surrounding vaccinations, they are an absolute necessity to save lives and preserve the health of future generations. We are already seeing a reemergence of nearly eradicated diseases and a devastating number of deaths that may have easily been prevented. If individuals continue to choose not to vaccinate, not only will the number of deaths continue to rise, but it is inevitable that these rare diseases will become commonplace and be allowed to evolve into even deadlier and more resistant diseases for which we will have no means of preventing.

Protecting and conserving public health

Ensuring compliance with immunizations is critical to preserving public health. Vaccinations promote the general health of an entire population because they support herd immunity, the concept that vaccinated individuals help to protect those that are not eligible to receive vaccinations, including babies too young to receive vaccinations, pregnant women and the immunocompromised. By ensuring that deadly diseases are not becoming apparent in individuals in whom it can easily be prevented through immunization, it in turn protects those unable to receive the vaccinations from the same diseases [16].

Similarly, the opposite is also true in that if individuals choose not to receive vaccinations, eradicated diseases can reappear placing entire communities in danger. When an individual receives vaccinations, he or she becomes immune to the disease which halts the disease's opportunity to spread to those who are unvaccinated. Thus, the more individuals who are vaccinated will effectively limit the spread of diseases entirely [17].

One of the threats to vaccination is the increasing popularity of the field of naturopathic or alternative medicine. There is a tendency toward antagonism of vaccinations by naturopathic doctors and this mentality is in turn passed down to their patients. A recent survey showed that only 12.8 % of students in naturopathy school were supportive of the full pediatric vaccination schedule [18]. Another survey done at the Ontario naturopathic clinic showed that 8.9 % of children receiving care there had not been vaccinated. While naturopathic medicine can provide alternative means of treatment and relief for patients, it is important that claims made by this field are supported by scientific research before being passed down to patients as facts.

Recent studies have shown that many healthcare workers decline routine vaccinations such as the seasonal influenza vaccine. This is a

group of medically educated individuals who have direct interaction with susceptible patients to whom they can transmit illnesses [19]. This in itself is a strong piece of evidence that further education needs to be provided to the public, including those within the medical field. A critical initial step in ensuring all eligible individuals receive vaccinations and in turn preserving public health is to broaden education on the necessity of vaccinations to the public and debunk theories contributing to resistance to immunizations.

Promotion of health advantages of vaccinations vs. disadvantages

The benefits of vaccination far outweigh any associated disadvantages because simply put, vaccinations save lives. Vaccinations have done more than any other medical intervention including antibiotics and surgery to save lives [20]. Additionally, not only do vaccines prevent deadly diseases, they also prevent devastating complications associated with several illnesses including blindness, deafness and paralysis [20].

Additionally, vaccinations are the more economical choice for the medical field. It is evident that preventing diseases via vaccinations is more cost effective than treating diseases. A 2005 study showed that for each dollar spent the vaccination program saved five dollars in direct costs and eleven dollars in additional costs to society [21]. The finances saved through vaccinations can be utilized for treatment of other diseases that do not yet have a means of prevention and in turn save countless number of more lives. For example, in the United Kingdom, it was shown that pre-pandemic vaccination, for example with the influenza vaccine, could save from 0.13 to 2.3 % of the GDP just over the course of one year [22]. A study done in the Netherlands showed that the government return for vaccinating adults age 50 with DTAP, influenza, pneumonia and varicella yielded a benefit-cost ratio of 4.09 demonstrating a fourfold rate of return for the government [22]. A study in Egypt, looking specifically at rotavirus in infants demonstrated that the investment costs in the vaccine were fully returned to the government by the time the infants turned twenty-two years old [22]. Per the World Health Organization, the annual cost of treating an influenza epidemic accounts for a cost burden of \$87.1 billion dollars and \$13,000 in hospitalization bills in pediatric populations [23]. In Ontario, Canada a universal vaccination program was introduced and it was shown to reduce the number of influenza cases by 61 % and associated deaths by 28 %. Additionally, this universal vaccination program did cost twice as much as a targeted vaccination program however in the long run it reduced healthcare costs by 52 % by decreasing the rate of influenza cases needed to be treated [24]. These studies show that investing in vaccines ultimately saves money while also providing a benefit to recipients of vaccines.

In terms of disadvantages of vaccines, all medications have side effects. That being said, vaccines are considered one of the safest medications with a generally low side effect profile. The most severe side effect, anaphylaxis, is rare and occurs only at a rate of approximately one per million doses for the majority of vaccines according to the CDC [25]. The rare risk of a severe allergic reaction from a vaccination is significantly lower than the deadly risks associated with the diseases that are being vaccinated against.

Social Media Influence on Vaccinations

In a time where 57 % of the world population is now connected to the internet (52 % accessing the web via mobile devices and 45 %

are active social media users), it is wondered why misinformation regarding vaccine safety still seems to outstand the majority of credible health sources who condemn it online [26]. A quick Google search of the question “Are vaccines safe?” will return a page full of pro-vaccination related results published by websites like the World Health Organization, Vaccines.gov (owned by the US Department of Health and Human Services) and the US Centers for Disease Control and Prevention. Mainstream media regularly promotes the debunking of unfounded anti-vaccination claims in their news coverage, as demonstrated after the recent 2019 measles outbreak in the United States. Social media companies like Facebook, YouTube and interest have already made direct changes to their platform policies and algorithms to combat the spread of health-related misinformation through their sites [27]. Yet, despite being what seems to be the most widely supported stance in this growing debate, the pro-vaccination movement has not yet gained the necessary traction among vaccine-hesitant groups online to truly combat the spread of anti-vaccination propaganda.

As part of this research, we aim to propose 3 primary reasons why the anti-vaccination movement has performed so highly online in recent years, and to provide recommendations on how to improve the performance of pro-vaccination content among vaccine-hesitant individuals online. The 3 reasons anti-vaccination content still remains prevalent online are as follows:

- The dominance of pro-vaccine arguments in mainstream media squanders the opportunity for comprehensive public discourse about the safety of vaccines and pushes curious, well-intentioned parents towards private online forums and social media groups where misinformation regarding vaccines often circulates
- Much of the online content produced by the pro-vaccination movement on social media categorizes individuals who feel any range of hesitancy towards vaccinations into a singular, “anti-vaxx” group. This generalization ignores a significant variety of attitudes and concerns among vaccine-hesitant individuals and limits the ability of pro-vaccination content to resonate with them
- The primary features of social media platforms intended to improve user experience are the very features that enable the curation, spread and preservation of anti-vaccination content, which is known to utilize false information

Dominance and aggression of pro-vaccination media

The overwhelming dominance and aggression of pro-vaccination advocacy in mainstream media is pushing undecided parents towards private, anti-vax online communities. The internet is a seemingly infinite repository of information that has become integral in supporting our individual decision making processes. For parents especially, search engines and social media are perhaps the fastest resources available when uncertainty arises in our everyday lives. In a study reported by AdWeek from 2016, 71 % of millennial respondents stated that they utilize parenting blogs, parenting websites, forums, and social networks to help guide their own parenting decisions [28]. Part of this online researching process includes finding information about important health-related decisions they make for their children-such as vaccinations.

Currently, mainstream media in the US is predominantly pro-vaccine--despite the growing traction that anti-vaccination arguments have gained online. On social media, individuals who respond to

pro-vaccination content with hesitancy or rejection tend to be quickly attacked for their beliefs. While this behavior is intended to stop anti-vaccination messaging from gaining popularity, it has a damaging effect on the opportunity for on-the-fence parents to publicly voice their concerns and questions about vaccine safety. Many of the responses targeted towards anti-vaccination comments, attack those individuals' underlying motivations and level of intelligence. They also typically include more emotional rhetoric than the anti-vaccination comments [29]. They use offensive memes that poke fun at anti-vaccination beliefs as a lighthearted tool to dismiss their opposers. A meme is defined by Merriam-Webster as "an amusing or interesting item (such as a captioned picture or video) that is spread widely online, especially through social media" [30]. An article by Alex Berezow clearly states the "celebration" of pro-vaccination memes [31]. He praises the solicitation of memes advocating that those who are vaccine hesitant are "morons...people living in traditional times... illogical...uneducated...and easily misguided and confused", by fictional media [32]. Together, these behaviors contribute to an "us versus them" mentality that stifles the opportunity for respectful conversation between both sides. The World Health Organization (Europe) publicly discouraged these conversation tactics in a guidelines document for effectively communicating with vaccine deniers published in 2017. In it, they also stress the importance of acknowledging the other individual's specific concerns and avoiding arrogant rhetoric in order to have any influence on their position.

Despite those recommendations being made, individuals who show any hesitancy towards pro-vaccine content in mainstream media are still frequently dismissed by a wave of derogatory comments. This deters on-the-fence parents from openly sharing their concerns with their peers on social media out of fear of being insulted or ostracized. Instead, they use social media search engines to investigate vaccine-related content and get drawn into private groups and pages that act as safe havens for openly anti-vaccine dialogue.

It only takes a handful of engagements with anti-vaccination pages and groups for social media algorithms to start placing anti-vaccine content on a user's home feed, especially on Facebook. Facebook's algorithm uses past online behavior to detect interests and pull in content from pages that seem most relevant to the user [33]. For a new or soon to be parent, viewing anti-vaccination content at a higher frequency can unconsciously influence their decision making by eliciting the availability heuristic or negativity bias. The availability heuristic is a psychological tendency humans have to believe that instances which are more easily remembered (and typically more shocking) occur at a higher frequency. With respect to anti-vaccination content, the availability heuristic functions when parents "tend towards remembering or rehashing rare or distant instances in which vaccines have failed, as opposed to understanding and retaining all the instances in which vaccines have worked and prevented illness" [34]. The negativity bias is the tendency we have to place more weight on negative information than positive information-especially when making judgments. Thus, content that espouses the alleged risks and consequences of vaccines can have a stronger immediate influence on a parent's attitude towards vaccinating their child than content that highlights the benefits of vaccines. The pages and groups that post anti-vaccination content leverage these biases along with the emotional vulnerability of new parents when crating their content. This gives way for a systematic spread of misinformation that explains why so many well-intentioned individuals can quickly fall down a rabbit hole

of anti-vaccination content. Furthermore, the inefficient conversation methods being utilized on social media to respond to vaccine-hesitant comments only exacerbate this issue.

Broadening perspective of anti-vaxx groups

Pro-vaccination advocates often categorize individuals who feel any range of hesitancy towards vaccinations into a singular, "anti-vaxx" group. This generalization ignores a significant variety of attitudes and concerns among vaccine-hesitant individuals and limits the ability of online pro-vaccination content to resonate with them.

While research in the context of social media is limited, one article published by the University of Pittsburgh Center for Research on Media, Technology and Health used various analytical methods to identify four sub-groups of users who engage with anti-vaccination content on Facebook [35]. The sub-groups are listed below.

Trust	Suspicion of the scientific community and concerns about personal liberty.
Alternatives	Focused on chemicals in vaccines and the use of homeopathic remedies instead of vaccination.
Safety	Focused on perceived risks of autism and concerns about vaccination being immoral.
Conspiracies	Suggests that the government and other entities hide information that this subgroup believes to be facts.

The sub-groups splintered from a longer list of common themes found through their study of anti-vaccination comments on Facebook. These themes echo the messaging that circulates anti-vaccination pages and private groups, such as the claim that vaccines are linked to autism.

The University of Pittsburgh Center for Research on Media, Technology and Health study was released two years following the publication of the World Health Organization's best practice guide on "How to Respond to Vocal Vaccine Deniers in Public", which outlined three of the four proposed sub-groups above in a list of top five anti-vaccination topics. The sub-group labeled as "conspiracies" in the Facebook study was instead broken out as two distinct topics of vaccine denial: "Effectiveness" and "threat of disease". WHO's identification of these topics was done through their own previous observations rather than hard data, but their conclusions ultimately aligned with the sub-groups found in the University of Pittsburgh research study.

The primary takeaway of both organizations' work is to acknowledge the diversity in beliefs that make up the anti-vaccination movement and the need for more specialized intervention by pro-vaccination advocates. The content posted by anti-vaccination pages and groups on social media targets specific segments of anti-vaccine beliefs with tailored messaging, and ultimately resonates with audiences on a personal level. There are plenty of anti-vaccination groups and accounts dedicated to producing content that speaks to just one of the four sub-groups of anti-vaccination attitudes described above. In contrast, pro-vaccination content in mainstream media has struggled to resonate with or persuade vaccine-hesitant or vaccine-denier individuals on a personal level. This is due to their overgeneralization of anti-vaccination beliefs on social media and the reluctance by pro-vaccination advocates to listen to the various concerns of opposers

before attacking their arguments. The senior author of the research article Brian Primack, MD, PhD, stressed this conclusion in a recent interview about the study: “If we dismiss anybody who has an opposing view, we’re giving up an opportunity to understand them and come to a common ground” [35].

Primary features of social media platforms

The primary features of social media platforms are intended to improve user experience. These very features enable the curation, spread and preservation of anti-vaccination content, which is known to utilize false information.

There are a variety of factors that make social media perhaps the best channel for spreading controversial content on a large scale. They include:

The ability to reach a wide range of audiences through “sharing” pieces of content

Sharing is a key part of almost every social media platform. Users can “retweet” on Twitter, re-post on Instagram, “pin” on Pinterest, and share on Facebook. It is a feature that allows users to satisfy a variety of psychological needs--relationship building, self-fulfillment, supporting a cause--all with the click of a button. When individuals feel motivated enough to share another’s post with their entire their social network, the content reaches new audiences that it may never have reached otherwise. Every friend or follower within an individual’s immediate network gains the possibility of viewing the content that’s been shared with them, as long as an algorithm permits it. This is what enables the virality effect of posts that are often shocking, emotional, and possibly untrue or harmful. The impact that sharing content has on people’s thoughts and behaviors have been magnified further by the empowerment of celebrities and influencers on social media. They possess the ability to cast a wide net on social media platforms. Celebrities have authority and sentiment towards them that amplifies the sharing process even further. When these individuals become the sources or advocates of misinformation, it becomes far easier for that content to gain traction across the world within a short amount of time. Among openly vaccine-hesitant U.S. celebrities include Jenny McCarthy, Rob Schneider, Jim Carey, Jessica Biel, Robert F. Kennedy Jr. and Robert DeNiro [36]. Many have used their platforms to influence attitudes surrounding vaccination-related legislation while citing previously de-bunked scientific studies and government-based conspiracies for support. Their use of false reasoning to support the sharing of vaccine-related misinformation has amplified the reach of anti-vaccination content on social media beyond what has already been achieved by anti-vax groups and pages.

Social grouping of users with common interests

At its very core, social media was created to connect people online. Today, the developments made by platforms like Facebook and Twitter make connecting and engaging with users based on common interests easier than ever before. Facebook provides users with the ability to create “groups”, which are essentially forum-like communities that “allow people to come together around a common cause, issue or activity to organize, express objectives and discuss issues, post photos and share related content” [37]. Without thorough oversight, abusive or inappropriate groups can gather endless amounts of members without being shut down. In April of 2019, Facebook announced

a global initiative to ban white supremacist hate groups across its platform following the New Zealand Christchurch mass shooting. However, over a month later, many of the banned groups located in the US had simply reorganized into different Facebook groups using very similar page names--seemingly dodging the system [38]. While there are reporting features in place for regular users to call out groups and pages that spread content in violation of Facebook’s policies, privacy settings make it simple for groups to hide their internal content from nonmembers. Additionally, even when these malicious groups are disbanded, the members are not prevented from gathering again elsewhere--leading to the same type of cyclical reorganizing as described in the story above. Private anti-vaccination groups and the content that they post have yet to be targets of removal by Facebook and most other platforms, since the issue of free speech is inherently sensitive in the realm of social media. However, they still often manage to evade the down-ranking initiatives instituted to limit their reach in search results and suggested content feeds.

Fine-tuned news feed algorithms

Each social media platform uses a different algorithm designed to filter and sort through content as it is posted by accounts within a specific person’s social network. As a result, not all content posted by friended or followed accounts of a user will appear in their news feed. While the details of each algorithm are kept private by these platforms, most are known to prioritize personal relevance and recency when combing through content [39]. The overall truthfulness or validity of information included in posts, however, is not as prioritized. As a result, most of what a user sees on a day-to-day basis on their social media feeds is a tightly refined segment of content that is optimized based on their behavior and interests. This creates an echo-chamber of content that consistently affirms the user’s current views, opinions and limits their exposure to content that opposes them. These algorithms, designed to keep users engaged and online for as long as possible, enable social media platforms to successfully monetize advertising spots on their sites and turn astounding profits. In 2018 alone, Facebook achieved \$55.01 billion dollars in advertising revenue across its platforms (including WhatsApp and Instagram) [40]. They have a clear monetary incentive to continue perfecting their algorithms so that users spend more time on their platforms. However, there is an intangible cost of creating an online echo-chamber that shields them from opposing beliefs and enables the internalization of misinformation. Without any external sanctions or true public outcry, it is unlikely that social media companies will choose to prioritize the ladder.

Paid advertising on social media is not only used to influence consumers’ purchasing behaviors. It is also used by different organizations--some with very controversial intentions--to spread certain ideologies and evoke specific emotions among the people they target. The enormous amounts of personal data collected by social media companies and third parties online allows for highly advanced targeting capabilities in social media advertising tools. As a result, organizations like anti-vaccination groups focus their advertising dollars towards users of particular demographics and online behaviors that identify them as being susceptible to particular messaging. While these targeting features are designed to help marketers reach consumers with a higher potential to convert into customers, they can be abused by groups with malicious intentions--such as the fraudulent political ads and pages created on Facebook by foreign countries to

influence political attitudes in the US [41]. Anti-vaccination groups have been known to target pregnant women and mothers in the past with ads containing misleading information regarding vaccines and promotions for “natural” medical alternatives [42,43]. A study conducted by The Daily Beast found that among seven popular anti-vax Facebook pages, 147 ads were purchased and primarily targeted towards women above the age of 25. By the time their study concluded in early 2019, they estimated that the ads had been viewed between 1.6 and 5.2 million times [17]. Facebook has been called out in the past by various news sources for allowing this type of fraudulent ad content to be published on their platform [44]. It was only this year that they (and other social media companies) finally promised to make larger strides in blocking health-related misinformation from being sponsored on their platform [45].

These are just a handful of features that make social media an extremely effective tool to spread misinformation. That is clearly not the intended use of these platforms, but there are unfortunate side effects in creating an online environment where keeping users engaged with content is the main feature. While each social media platform has policies beyond those mentioned here to prevent this type of content from spreading, we believe that there are more changes that can be made by both social media companies and pro-vaccination advocates to effectively fight back against the presence of anti-vaccination content online.

Ethical Analysis

The United States, one of the most developed countries in the world, is on the verge of losing its World Health Organization designation as a country that has eliminated measles, because of the numerous outbreaks this past year. The anti-vaccine campaign and those parents who are vaccine hesitant are not only placing their own children at risk, but are jeopardizing those children who cannot be vaccinated for medical reasons and think they are being protected by herd immunity. Rumors and misinformation abound on the Internet. Parents are suspicious of Big Pharma, they don't trust scientific studies, they have lost confidence in pediatricians and the CDC, and their suspicions are being supported by celebrities on social media giving testimonies about the horrors of vaccinations. As a result, numerous anti-government libertarians advanced the anti-vaccine movement that has taken root and convinced parents not to allow physicians to dictate treatment decisions for their children. There is an urgent need in this country to counter-act the anti-vaccine groups and make sure that parents are well-informed about vaccinations and that their children are well protected. The majority of American parents do have their children vaccinated. Groups are forming like “Voices for Vaccines” to counter anti-vaccine groups. States are limiting philosophical and religious exemptions to vaccines. However, more policy solutions must be advanced that will support pediatricians in demanding that children in their practice are vaccinated unless they have a legitimate exemption in order to protect the most vulnerable children in society. We cannot allow these rumors and misunderstandings and lack of accurate data to stand in the way of life-saving treatments. Ethically, pro-vaccine groups must stand up and advocate for the most vulnerable members of our society. Solutions must be advanced that will protect the lives of children and improve their quality of life and survival. This is imperative for the children, their families and society as a whole. It will be argued that-according to the ethical principles of respect for persons, beneficence/nonmaleficence, and justice-action

must be taken immediately to address the concerns surrounding the misunderstandings about vaccines and the lack of education regarding vaccines for the best interest of all. Such action will not only save lives, but will also do much to conquer many of these diseases.

Respect for Persons

This principle incorporates two ethical convictions: First, that person should be treated as autonomous agents; and second, that persons with diminished autonomy are entitled to protection. The principle of respect for persons thus divides into two separate moral requirements: The requirement to acknowledge autonomy and the requirement to protect those with diminished autonomy [46]. Respect for human persons refers to the right of a person to exercise self-determination and to be treated with dignity and respect. All people deserve autonomy and to be treated with dignity and respect. Failure to provide any person with adequate health care, which includes the failure to protect children from preventable diseases, violates this basic right of respect for persons. Proper education about vaccines and the diseases they prevent, government policies that protect vulnerable children, and using social media as a valuable tool to counter-act misinformation and rumors, will respect the rights of all people.

Second, as an autonomous agent an individual has the right of informed consent. Since children are minors, unless emancipated, parents have the right to know all information about their child's diagnosis, prognosis, treatment and care plan. The elements of informed consent include professional disclosure, patient comprehension of the information, patient voluntariness and competence to consent. This means that parents have the right to know the accuracy of vaccines, but must be told that none are 100 % safe, because that is not a standard we use in medicine today. “A committee of experts known as the Advisory Committee on Immunizations Practices annually recommends an evidence-based schedule for every vaccination to the Centers for Disease Control and Prevention. No other schedule for any vaccine provides better safety or efficacy” [47]. Questions about risks and benefits must be addressed by pediatricians and other side effects that may impact their children in the future. Unless pediatricians provide parents with full knowledge about the vaccines for the 14 recommended diseases, they are not providing these patients and families informed consent. This will entail working collaboratively and establishing a Federal Vaccine Monitoring System that identifies potential problem areas in the United States, designs vaccine-positive campaigns that negates the false information on social media and gives accurate statistics. Studies show that “proper vaccinations can prevent an estimated 42,000 deaths over the lifetime of each American birth cohort”. Unless parents and the public at large are made aware of these statistics, the long-term health related effects and the emotional and lifestyle consequences of vaccines; they will not be able to make informed decisions and we will be unable to protect those children in society who cannot be vaccinated for medical reasons. For informed consent to occur, pediatricians must have accurate data about the efficacy of vaccines, and knowledge needed of what is presently available in regards to evidence-based scientific studies. Transparency is a must in regards to vaccine studies. Only when the criteria are met will true informed consent be assured.

Children are minors but in the field of pediatrics physicians and bioethicists believe that children have the right of assent in regards to medical treatments and procedures. This does not apply to infant

vaccinations, but later on when a child may wish to be vaccinated against the consent of his or her parents. Assent is when an individual who lacks decisional capacity, or decisional authority, agrees to go along with a proposed medical intervention for him or herself. It should include the following four elements: First, helping the child achieve a developmentally appropriate awareness of the nature of his or her condition. Second, telling the child what he or she can expect with tests and treatments. Third, making a clinical assessment of the child's understanding of the situation and the factors influencing how he or she is responding (i.e. voluntariness). Fourth, soliciting an expression of the child's willingness to accept the proposed treatment or procedure. Regarding this final point, we note that no one should solicit a patient's views without intending to weigh them seriously. In situations in which the patient will have to receive medical care despite his or her objection, the patient should be told that fact and should not be deceived [48]. The problem is that many pediatricians are not prepared to discuss the issue of vaccinations with minors whose parents object to the vaccinations. Many pediatricians are hesitant to intervene between child and parent. The focus for these pediatricians must be on what is in the best interest of their patient. The child is their immediate patient. Immunizations not only protect the child from serious diseases but protect others who for medical reasons cannot be immunized. In addition, pediatricians know these immunizations are safe and effective. Minors who request immunizations from their pediatricians should be given the right of assent. The American Medical Association supports this notion of assent and is supporting state bills that will allow minors to ask for vaccinations against the wishes of their parents [49]. Assent is a basic guideline within the principle of respect for persons.

The failure of pediatricians and parents to be proactive in addressing the medical needs of this most vulnerable population in regards to immunizations against deadly diseases is causing needless suffering and possibly even more deaths. Wiener et al. argue that "the complexity of the therapeutic relationship that involves the medical team, parents or guardians whose views may themselves differ, and a patient whose capacity to make medical decisions is somewhere along a continuum of complete dependence to complete independence, cannot be underestimated" [50]. To deny children the right to life saving immunizations that may help them and others clearly violates the ethical principle of respect for persons and our responsibility to help others in society.

Beneficence/Nonmaleficence

The principle of beneficence involves the obligation to prevent, remove, or minimize harm and risk to others and to promote and enhance their good. Beneficence includes nonmaleficence, which prohibits the infliction of harm, injury, or death upon others. In medical ethics, this principle has been closely associated with the maxim *primum non nocere* ("Above all, does no harm"). The amount of misinformation and rumors about immunizations is one factor that has led to the decrease in the rate of vaccinations in the United States. This lack of public education has allowed some parents to believe that the risks of vaccinations outweigh the benefits, which is clearly untrue. Vaccinations save lives.

Pediatricians and researchers have, as moral agents, an ethical responsibility to treat their patients in a way that will maximize benefits and minimize harms. Failure to adequately communicate and educate

patients and families about vaccinations, short and long term effects and other side-effects, is not in the best interest of the patient, their families or the society as a whole. Safety concerns about vaccines make up two-thirds of the reasons why parents refuse vaccinations for their children. Researchers must continue research in the area of vaccine safety but only to evaluate scientifically grounded hypotheses, not in response to dubious conspiracy theories. Literature and research studies have confirmed not only do vaccines prevent deadly diseases; they also have the ability to prevent devastating complications associated with several illnesses including blindness, deafness and paralysis. To maximize benefits and minimize harms, pediatricians must educate parents about the importance of vaccines and the problems associated with delaying or deviating from the routine schedule. It is understandable that some pediatricians want to be flexible with parents in regards to staggering vaccinations, however, those who are "vaccine hesitant" leave their own children without adequate protection and jeopardize society as a whole. Pediatricians must act in the best interest of their patients and avoid making decisions that would harm their patients. Refusing to vaccinate their patients, delaying vaccinations, allowing patients to remain in their practice who are not vaccinated and do not have a medical exemption, not only harms the patient but has the potential to harm others in their practice and in society.

It is clear, after reviewing statistics and studies and identifying the biases and stereotyping that exist in medicine due to the misinformation on social media that unless there is a concerted effort to organize a public policy campaign that negates the misinformation and rumors on social media about vaccines, many children will be exposed to unnecessary risks, including more suffering and even more deaths. Pediatricians have a moral responsibility to do what is good for their patients. Should a pediatrician be impeded in the exercise of his or her reason and free will because of fear that parents will leave their practice because the pediatricians demands the child be immunized or fear that parents will speak out against the pediatrician and damage their reputation in the community, then that pediatrician has an ethical responsibility to overcome those impediments and do what is demanded by the basic precepts of medicine—seek the patient's good. Physician advocacy groups, researchers, pediatric hospitals and medical associations have a responsibility to their communities. If these entities have the ability to increase knowledge about vaccinations through public education, can optimize further research showing the necessity and safety of vaccines for children on a scheduled basis and can support pediatricians who demand that their patients be immunized or leave their practice, then it is their ethical responsibility to formulate programs that address this immediate need. The one aspect that pediatricians, researchers and parents have in common is the desire for the safest and most effective vaccines possible. To bring this about we need transparency, honesty and a focus on the best interest of the child. Failure to recognize this great need is a failure not only of the test of beneficence; it may also be a failure of the test of non-maleficence.

Justice

This principle recognizes that each person should be treated fairly and equitably and be given his or her due. The issue of childhood immunizations also focuses on distributive justice: The fair, equitable and appropriate distribution of medical resources in society. At a time when reforming healthcare in this country has become a high

priority, failure to initiate preventative measures that would save medical resources and possibly human lives in the long-run violates the principle of justice and specifically distributive justice.

Accurate information about the benefits of childhood vaccinations, collaboration among various medical associations, federal agencies and public advocacy groups is vital if we are going to protect our children today and protect future generations from these dangerous diseases. Preventing diseases through vaccinations is a cost effective way of treating diseases. As stated above, a 2005 study showed that for every dollar spent on a vaccination program we save five dollars in direct costs and eleven dollars in additional costs to society [21]. The savings associated with preventing childhood disease is not only beneficial for children in the United States but the costs saved by vaccinations will help defray the costs of medical care in other areas. All children have the right to be treated fairly and equitably. Studies have confirmed that the 14 required vaccinations for children in the United States are not only medically necessary and have the potential to decrease suffering and save lives, but they also protect those children who cannot be vaccinated because of medical exceptions. These life-saving vaccines protect vulnerable children by preventing outbreaks and save health care dollars that can be utilized for prevention of other diseases. Justice in the fight against childhood diseases will only be assured if there is a coordinated national collaborative group that will develop a public education policy for the best interest of all children.

Americans espouse the belief that all men and women are created equal. Equality has also been a basic principle of the medical profession. If we truly believe in equality, we should insist that all men, women and children receive equal medical treatment and resources. The basic trust parents have in vaccines is being eroded and as a result, there is a fear that these basic tools of prevention are in danger of becoming useless. Denying medical treatment to children in the form of vaccinations because there is a lack of accurate information and a failure of negating misinformation and rumors on social media not only places children's lives in danger but is an unjust allocation of resources and violates a basic tenet of justice. Pediatricians, clinical researchers, the medical profession and the appropriate government agencies have an ethical obligation to use available resources fairly and to distribute them equitably. Failure to do so is ethically irresponsible and morally objectionable. To compromise the basic ethical foundations upon which medicine stands is destructive not just to children but to society as a whole.

Recommendations

The following recommendations are being proposed to advise medical professionals, educators, and social media users on how to respond, react, and overcome the anti-vaccine movement. This process will fortify and promote a strong pro-vaccine agenda. Our recommendations are detailed as follows:

Formation of the Fraudulent Vaccine Information Force (FVIF)

As a unit derived from a state Department of Public Health, active researchers navigating social media platforms can appropriately reply and/or report misinforming or fraudulent information attacking the scientific success of vaccinations. The FVIF, ideally, would be an interdisciplinary team that would include medical residents, nurses, law students, medical students, journalists and public relations specialist.

This organization will be an active defense against toxic misinformation and advice, while serving as an efficient source of evidently supported vaccine information. The FVIF will be able to debunk fraudulent articles, posts, groups, speakers, and websites on the internet that renounce the success of vaccinations. The FVIF can define a "stamp of approval" for internet content that supports vaccinations, so that users can immediately interpret that the information they are reading is fact based and supported professionals in medicine, law, and journalism.

One major issue that could foreseeable arise with the FVIF is access to content spread amongst internal groups on social media. Though this is difficult to navigate and gain access to, we advise that social media platforms support the formation of groups with similar missions to the FVIF, in debunking false information on their platforms. Advisors of the CDC and infectious disease pediatrician, Dr. William Moss, believe that in the past, doctors' groups and organizations like the CDC have missed opportunities to communicate the dangers of vaccine-preventable diseases. This opportunity was missed. Anti-vaxxers have circulated videos on social media of mothers citing false claims about vaccines, while public health groups failed in challenging their claims with factual stories of how a son or daughter died from diseases like measles or polio [4]. With a task force designated to take action against anti-vaccine activist groups, the opportunity to communicate the dangers of these diseases will be taken advantage of, communicating factual and supported information of the success of vaccines.

Tightening broadly defined religious exemptions and elimination of philosophical exemptions

Philosophical exemptions should be eliminated from the exemption compromise. This is a stance that the American Medical Association has supported, while incentivizing states to support bills that will allow minors to accept immunizations even if their parents refuse those [49]. Philosophical exemptions or personal belief exemptions are rooted in a personal morality. There is nothing immoral about the success of vaccinations; therefore the objection to them on a moral basis is invalid. To protect public health, legislative bodies cannot allow for misinformed judgments and decisions by well-intentioned parents. A way to do so is by administering vaccinations and dismantling legislature allowing for personal belief exemptions. Philosophical exemptions are unnecessary and an ambiguous facade of overprotection of an individual's insecurity. Two of the three states that eliminated personal belief exemptions (religious and philosophical) have not had a measles outbreak recorded in 27 years. However, twelve of the eighteen states that allowed for all three exemptions recorded a measles outbreak in their state within the past year.

Critical restrictions on Medical Exemptions with removal of religious and philosophical exemptions

Since religious and philosophical exemptions were removed in 2015 in California by SB 277, medical exemptions have increased 250 % from 0.2 % in 2016 to 0.7 % in 2018 [9]. Many of the schools that once lead the state in philosophical exemptions now lead the state in medical exemptions [51]. It is obvious that medical exemptions have been issued in California when they are not warranted, merely replacing a previous religious or philosophical exemption. Medical exemptions must be obtained from a physician. Medical professionals have an obligation to protect the public health to the best of their

ability. One way to do so is by administering vaccinations, keeping vaccine-preventable diseases causing an outbreak. Because medical exemptions have been mishandled in California after SB 277, we believe that medical exemptions should be written by a team of physicians, but approved by the state Department of Health. Elimination of both religious and philosophical exemptions has been a successful strategy to preserve public health.

Mississippi joined West Virginia's medical exemption only status in 1979, when its Supreme Court found the state's religious exemptions to be unconstitutional—the only such ruling so far; the court cited a previous ruling, *Prince v. Commonwealth of Massachusetts*, that determined “the right to practice religion freely does not include liberty to expose the community or the child to communicable disease or the latter to ill health or death” [11]. Mississippi, like West Virginia, has some of the highest vaccination rates in the country and hasn't had a measles outbreak since 1992.

Disposal or regulation of compensation laws of NCVIA

Under the National Childhood Vaccine Injury Act (NCVIA), the Vaccine Injury Compensation Program (VICP) operates as a no-fault compensation program for petitions proposing injuries caused by vaccinations. The process includes: 1) Filing a petition to the US Court of Federal Claims, 2) US Department of Health and Human Services medical staff reviews the petition and determine medical criteria for compensation, 3) The report is presented to a court-appointed special master, who decides whether the petitioner should be compensated, often after holding a hearing in which both parties can present evidence. If compensation is awarded, the special master determines the amount and type of compensation, 4) The Court orders the US Department of Health and Human Services to award compensation.

The VICP has awarded a total of \$ 4 billion in compensation. While this total may look discouraging for the success of vaccinations, 70 % of the \$ 4 billion is a result of negotiated settlements in which the Department of Health and Human Services did not conclude, upon investigation, that the vaccines caused the alleged injury [52]. The \$ 4 billion compensated for injury allows the assumption that vaccines are harmful, when truly they rarely inflict minor injuries. If vaccinations were not the cause of the majority of injuries, then why is compensation being settled under the VICP? Disposal or regulation of the compensation program protects the image of vaccinations, which can help sway vaccine hesitant individuals.

Use of *Annals of Internal Medicine* publication to refute Autism links in Lancet

“Measles, Mumps, and Rubella Vaccination and Autism: A Nationwide Cohort Study” is a publication in the *Annals of Internal Medicine* that addresses the false correlation of the MMR vaccine to autism. The research team investigated 657,461 children born in Denmark from 1999 through 31 December 2010. The study's results showed no increased risk for autism after MMR vaccination [53]. This study should be a primary reference source for users addressing vaccine hesitancy on social media. It can be used as an informative source instead of rebutting with discriminatory memes.

Patient removal from practice

Parents who refuse vaccinations for their dependents or themselves pose a severe health risk to patients within a pediatric practice

that are medically unable to receive vaccinations. Physicians should have the power to remove patients from their practice if, after being offered educational resources supporting the success of vaccinations, the patient or surrogate refuses vaccination. Educational resources should be offered within the lobby offices, patient rooms, and personally throughout a patient's visit. The removal of a patient from a practice is validated through the principle of nonmaleficence. The goal is to prevent further harm to patients that are not able to receive vaccinations because of medical justifications. It should be noted that physicians should assist those patients who are removed from the practice to find another physician so they are not abandoned. If a physician is reluctant to remove a patient from their office, creating particular scheduling options for the patient could prevent further harm to patients. While this will keep the patient within the practice, some vaccine-preventable diseases can remain airborne and still be hazardous to patients who are medically unable to receive vaccinations.

Tailored Immunization Programming

The WHO developed the Guide to Tailoring Immunization Programs (TIP). TIP is a program that attempts to diagnose barriers and motivators to vaccinations within low vaccination coverage communities. The program implements and designs tailored interventions to promote vaccination uptake within unvaccinated communities. These programs have been implemented in England, Lithuania, Bulgaria, and Sweden. The programs have reported success in raising immunization rates in under vaccinated communities. The immunization programs are focused on social science research as well as the interdisciplinary community engagement, which allows program to listen, learn, and gain an understanding of community and individual perspectives [54]. In addition, the study concluded that these programs ensured long-term change when immunization programs are focused and designed for specific communities [54]. These programs create the opportunity to be in solidarity with under vaccinated communities instead of ridiculing hesitant individuals on social media.

Conclusion

Social media has greatly influenced the resurgence of the Anti-Vaccination movement. Anti-vaccination activists have used social media to target vaccine hesitant communities. Vaccine hesitant individuals can be drawn into private social media groups where misinformation can circulate. Social media has enabled the spread of anti-vaccine content by using platform specific algorithms to enhance the user's experiences. Further faults in legislature and public latency have also contributed to the increase of unvaccinated children in the US. Legislature that allows for Philosophical exemptions empower complacency within vaccine hesitant communities. Vaccinations have been medically and clinically supported for their success in preventing the spread of infectious diseases. In addition, vaccinations are ethically supported through beneficence, nonmaleficence, and justice. Yet, the number of unvaccinated children in the US has quadrupled since 2001 [1]. While social media has been a large component of the tactics that the Anti-Vaccination movement has used, the recommendations included can be implemented to mitigate the spread of misinformation that discredits the success of vaccinations on social media and work to increase the number of children vaccinated in the United States.

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