

Measles Epidemic and Immunization Aversion

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Abstract

The focus of this article is to examine the public health and economic consequences of declining childhood vaccination, a result of a growing vaccine hesitancy movement using the example of the MMR vaccination rates and measles virus rates¹. Physical, cultural and religious, financial, emotional and educational barriers influencing Immunization acceptance will be identified.

The World Health Organization (WHO) recently labeled people's reluctance or refusal to become vaccinated as one of the top ten threats to global health in 2019 and is one of the leading contributors to global child mortality.^{2,3}

Although the United States (US) had achieved measles elimination in 2000, outbreaks have since occurred in the US and continue to occur globally.^{4,5,6,7}. These outbreaks are exacting a hefty toll on local and state health departments, draining resources and siphoning health care workers from other needs.

Introduction

The World Health Organization recently labeled people's reluctance or refusal to become vaccinated as one of the top ten threats to global health in 2019.² Although the US had achieved measles elimination in 2000 (as declared by the Center for Disease Control (CDC) and recognized by WHO), outbreaks have since occurred in the US and continue to occur globally.^{5,6,7} The Measles outbreaks are due to several identified causes as discussed in this article.

Immunization rates in the US, though improving, remain below target despite readily available effective and safe vaccines. This risks the resurgence of many infectious diseases with public health and economic consequences. Many ethicists believe that

vaccination is not merely a matter of personal choice, but it is also a social obligation.² Immunization benefits not only the individual but society as a whole; as disease in any part of this country is a threat to everyone.

Parental vaccine hesitancy and non-medical exemption allowances (NME) are major factors in low immunization rates and the alarming recurrence rate of serious, preventable illness, such as Measles.⁸ To ensure population-based herd immunity, 95% of the population need to be vaccinated.⁸ Low immunization rates place even greater risk to persons who cannot be vaccinated for medical reasons: those too young to be fully vaccinated, and those whom vaccines do not provide complete protection, such as the immuno-compromised patient.⁹ Studies show that response to Measles vaccination is reduced in malnourished children.¹⁰ Immunization rates are lowest in our poorest populations, such as immigrant, inner city and American Indian children, compounding the problem.

Measles importation is another significant cause of measles persistence in the US. Unvaccinated US residents returning from trips abroad comprised the overwhelming majority of imported measles cases in the US as opposed to foreign visitors. Over two thirds of US resident cases reported during 2009-2014 had a philosophical or religious objection to immunization. It is mainly for these reasons that low immunization rates contribute to health and economic burdens, making improving immunization rates a public health priority. Federal, state and local government share

Citation: Cynthia Helm (2019) Measles Epidemic and Immunization Aversion. *Journal of Emergency Medicine and Primary Care. ReDelve.* 2(2): 1-10.

Received Date: 13 September 2019; **Accepted Date:** 20 September 2019;
Published Date: 10 October 2019

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in the responsibility for improving these deficiencies. Measles outbreak control requires intensive public health responses to contain them.

Critical areas of focus to achieve US as well as global measles elimination include:¹¹

1. Early recognition of the illness is critical to limiting the transmission.
2. A committed global effort to eradicate measles.
3. Ensuring that the US maintains a high 2-dose vaccination coverage.
4. Reducing and monitoring the rates of vaccine exemption.

Thesis Statement

Measles once eliminated in the US as of 2000 has had a resurgence and now an epidemic due to immunization aversion. The focus of this paper is to examine the potential public health and economic consequences of declining childhood vaccination, a result of a growing vaccine hesitancy movement using the example of the MMR vaccination rates and measles virus rates.¹ This paper will identify physical, cultural and religious, financial, emotional, and educational barriers influencing Immunization acceptance.

Measles History

Measles (Rubeola) is caused by the morbillivirus and is extremely contagious. It is recognized by its classic red rash (Koplik spots) which covers most of the body.^{4,12,5}

Measles patients are contagious for 4 days prior and 4 days after the rash appears. The virus remains viable in the air for up to 2 hours. Exposure of unvaccinated, previously unexposed individuals will result in 90% transmission spread primarily through cough and sneeze. Patients feel extremely ill for approximately 7 days and up to 30% will suffer some sort of complication: 8% diarrhea, 7-9% ear infections which can result in permanent hearing loss, 1-6% pneumonia, .1- .3% encephalitis causing death in adults. A 5% death rate in children was found in medically underserved areas.^{4,11,5,13}

Measles illness during pregnancy has associated significant risks: maternal morbidity and premature labor, spontaneous abortion, low birth weight infants, premature birth and high risk of fetal loss. Measles in late pregnancy can lead to perinatal infection in the infant, which has a high risk of subacute sclerosing panencephalitis and mortality.¹⁴

Pre-vaccine Era

In the 9th century, a Persian doctor published one of the first written accounts of measles disease. Francis Home, a Scottish

physician, demonstrated in 1757 that measles is caused by an infectious agent in the blood of patients.⁶

In 1912, measles became a nationally notifiable disease in the United States, requiring U.S. healthcare providers and laboratories to report all diagnosed cases. In the first decade of reporting, an average of 6,000 measles-related deaths were reported each year.⁶

In the decade before 1963 when a vaccine became available, nearly all children got measles by the time they were 15 years of age. It is estimated 3 to 4 million people in the United States were infected each year. Among reported cases, an estimated 400 to 500 people died, 48,000 were hospitalized, and 1,000 suffered encephalitis (swelling of the brain) from measles.⁶

Vaccine Development

Childhood vaccines for common communicable diseases, such as measles, are among the most beneficial health care interventions worldwide.¹⁵

In 1954, John F. Enders and Dr. Thomas C. Peebles collected blood samples from several ill students during a measles outbreak in Boston, Massachusetts. The objective was to isolate the measles virus in the student's blood and create a measles vaccine. They succeeded in isolating measles in 13-year-old David Edmonston's blood.⁶

In 1963, John Enders and colleagues transformed their Edmonston-B strain of measles virus into a vaccine and licensed it in the United States. In 1968, an improved and less concentrated vaccine, developed by Maurice Hilleman and colleagues, began to be distributed. This vaccine, known as Edmonston-Enders (formerly "Moraten") strain has been the only measles vaccine used in the United States since 1968.⁶ Measles vaccine is usually combined with mumps and rubella (MMR), or combined with mumps, rubella and varicella (MMRV). The measles vaccine is effective 72 hours after administration.¹⁶

Measles Elimination

In 1978, CDC set a goal to eliminate measles from the United States by 1982.⁶ Although this goal was not met, the measles vaccine drastically reduced the disease rates. By 1981, the number of reported measles cases were reduced by 80% compared with the previous year. In 1989 measles outbreaks among vaccinated school-aged children prompted the Advisory Committee on Immunization Practices (ACIP), the American

Academy of Pediatrics (AAP), and the American Academy of Family Physicians (AAFP) to recommend a second dose of MMR vaccine for all children.¹⁶ Implementation of this recommendation and improvements in first-dose MMR vaccine coverage, showed reported measles cases declined even further.⁶

The US had achieved measles elimination in 2000 (as declared by the Center for Disease Control (CDC) and recognized by WHO). Measles elimination is defined as the absence of continuous disease transmission for greater than 12 months.

Current Incidence of Measles in the US

As of June 16, 2019, over 1,000 cases of confirmed measles have been diagnosed in 28 states. These outbreaks are taking a heavy toll on local and state health departments, draining resources and siphoning health care workers from other needs.¹⁶ Clark County, California Public Health department logged over 19,000 work hours and over \$800,000 spent on this preventable illness.¹⁶

New York has more measles cases than any other state. 588 confirmed cases in NYC and 334 in the rest of the state as of June 16, 2019. There are 6,000 unvaccinated students in New York state that have been excluded from public school and daycare.¹⁶

The estimated cost of each case ranges from \$7,500 to \$20,000.¹⁶ With approximately 8.7 million children aged 17 yrs or younger are susceptible to measles, there is a potential for large measles outbreaks even in the context of generally high vaccination coverage.¹¹ Susceptible children are under one year of age (this age group is at highest risk of complications), others have received MMR but not until later in childhood or adolescence, other children have altered immunity due to immunosuppression therapy and cancer treatments, and those who did not develop a protective response to vaccination.¹⁷

Although the US had achieved measles elimination in 2000, outbreaks have occurred in the US and continue to occur globally. Measles outbreak control requires intensive public health responses to contain them. Early recognition of the illness is critical to limiting the transmission. A committed global effort to eradicate measles as well as ensure the US maintains a high 2-dose vaccination coverage and reducing and monitoring the rates of vaccine exemption will be essential to achieve measles elimination.¹¹

Current Rates of Measles Abroad

Unimmunized people are a threat to everyone. Vaccine hesitancy is a global problem. Increases in vaccine preventable diseases has been observed in many countries.¹⁸ WHO tracks cases globally, indicating 20 million cases of measles occur annually. Numerous outbreaks with tens of thousands of cases reported on multiple continents, including those countries that US residents travel to frequently, have been documented.

WHO has 194 Member states; all of these are also member states of the United Nations except for the Cook Island and Niue. Complacency about the disease, the spread of false information regarding the vaccine, collapsing health system abroad, pockets of fragility and low immunization coverage are combining to bring about global resurgence of measles after years of progress. The Measles and Rubella Initiative is a partnership formed in 2001 of the American Red Cross, CDC, the United Nations Foundation, UNICEF, and WHO is tasked with improving sustained investments to improve immunization delivery and opportunity. This Initiative is committed to achieving the Global Vaccine Action Plan of measles and rubella elimination in at least 5 WHO regions by 2020.¹⁹

So far in 2019, 150 of the 194 Member states have shared their subnational data for vaccine administration.²⁰ The following is provisional data; 2019 official data will be available in July of 2020 as countries are still reporting cases for this year. Current estimates for total cases and deaths for 2019 will be released in November 2019.^{22,20,21}

As of April 2019, measles cases have continued to climb. Preliminary global data shows that reported cases rose by 300 % in the first 3 months of 2019, compared to the same period in 2018, which follows consecutive increases over the past two years.²² (24) Current outbreaks include: Democratic Republic of the Congo, Ethiopia, Georgia, Kazakhstan, Madagascar, Myanmar, Philippines, Sudan, Thailand and Ukraine. In recent months spikes in number of cases have also occurred in countries with high overall vaccination coverage (US, Israel, Thailand, Tunisia) where disease has spread among clusters of unvaccinated people.²⁰

WHO estimates that less than 1 in 10 cases are reported globally. Considering this, to date, 2019 has 170 countries report 112,163 measles cases. As of this time last year, 28,124 cases were

reported from 163 countries. Globally this is a 300% increase. WHO African region has recorded a 700% increase, Region of the Americas 60%, European region 300%, Eastern Mediterranean 100%, and 40% increase in the Southeast Asia and Western Pacific regions.^{22,20}

Measles is preventable through two doses of vaccine. 2018 reports show that for the past several years global first dose measles vaccine coverage of children (by their second birthday) has held steady at 85%, far below the 95% needed to prevent outbreaks.²². 171 countries report second dose coverage stands at 67%.

WHO recommends that every child receive 2 doses of measles vaccine as studies have shown a low serologic response of 72% after single dose vaccine.²³. Coverage of the second dose vaccine needs to increase globally. Today, 25 countries still need to make the 2nd dose a part of their essential immunization program.

^{24,25,19,26}

Causes of Measles Persistence and Resurgence

Erroneous Report of Vaccine Related Autism

A retrospective study found no link between the MMR vaccine and autism disorders, and that the decrease in MMR vaccination (or even withdrawal) did not influence the rate of autism.²⁷

In 1998 the LANCET published a British study by Dr. Andrew Wakefield and his associates linking Autism to MMR and other vaccines. This study was discredited and now retracted. Wakefield was accused of misrepresenting or altering the medical histories of all 12 of the patients whose cases formed the basis of the 1998 study. A review of Wakefield's study shows that of the 12 cases Wakefield examined in his paper, five showed developmental problems before receiving the MMR vaccine and three never had autism. According to British Medical Journal, Wakefield received more than 435,000 pounds (\$674,000) from the lawyers who planned to use the study to sue the vaccine manufacturers. Wakefield has been unable to reproduce his results in the face of criticism, and other researchers have been unable to match them. In 2010 Britain stripped Wakefield of his medical license.

Unfortunately, the article has done long-lasting damage to public health. This discredited paper panicked many parents and led to a sharp drop in the number of children immunized with MMR

vaccine. Vaccination rates dropped sharply in Britain after its publication, falling as low as 80% by 2004. Measles cases have gone up sharply in the ensuing years. In the US, more cases of measles were reported in 2008 than in any other year since 1997, and more than 90% of those infected had not been vaccinated or their vaccination status was unknown according to the CDC.²⁷

Measles Importation

According to the CDC about 50% of imported measles cases in the US are from unvaccinated US residents who were infected abroad in countries where measles is occurring.^{28,25}

Since MMR reached widespread use, measles cases in the US reduced by more than 99%. Measles was declared eliminated (absence of continuous disease transmission for greater than 12 months) from the United States in 2000 and maintenance of elimination was verified in 2011. This was due to a highly effective vaccination program in the US, as well as better measles control in the Americas region.^{6,5,11}

Globally, 20 million cases of measles occur annually. Numerous outbreaks with tens of thousands of cases reported on multiple continents, including countries that are visited frequently by US residents. The top 10 out bound destinations for US resident's international travel are: Mexico, Canada, Dominican Republic, France, Italy, Jamaica, Spain and China; making up 77.1% of international travel. The top 10 home countries for international travel to the US accounting for 78.5% of international travel is Canada, Mexico, UK, Japan, Brazil, China, Germany, France, South Korea and Australia.²⁸ Measles vaccination coverage rates for the top US resident international travel were generally lower than that of the US and the average incidence of measles in travel destinations was higher than that of the US. The total number of US residents travelling to countries with high measles incidence is 10 times higher than that of the cumulative number of unauthorized immigrants living in the US coming from countries with high measles incidence.²⁸ The risk of measles importations from unauthorized immigrants to the US is low in comparison to the documented risk from cases imported by US residents traveling to measles-endemic areas. Measles outbreaks in the US have been linked to intentionally unvaccinated children who travelled to countries where measles outbreaks were occurring.²⁸. This emphasizes the need for international travelers to follow the CDC recommendations for measles vaccination prior to travel.

Unvaccinated American Citizens. Unvaccinated American Citizens Who Travel

Unimmunized people pose a threat to everyone. Measles outbreaks often begin among unvaccinated individuals returning to the US after being infected abroad.^{28,11} Unvaccinated US residents returning from trips abroad comprised the majority of imported measles cases in the US as opposed to foreign visitors. Unvaccinated persons comprised the overwhelming majority of cases and outbreaks during 2009-2014 and over two thirds of US resident cases were reported as having a philosophical or religious objection and belonged to diverse subpopulations that spanned the spectrum on socioeconomic status as well as political and religious ideologies.^{28,11} The highest incidence occurred in children aged 12-15 months demonstrating the increased risk of young children around the age recommended for the first MMR dose.¹¹ Efforts to decrease the risk of measles in the US should focus on appropriate routine and travel specific vaccination for US residents traveling internationally. This highlights the need for international travelers to follow the CDC recommendations for measles vaccination prior to travel.²⁸

Immunization Aversion as Cause of Poor Immunization in the US

Vaccines are one of the greatest achievements in public health to prevent and minimize disease; yet a significant number if Americans remain at risk for vaccine-preventable diseases. (1,Table 1) MMR vaccination coverage for children in the US has remained below the target of 95% needed for herd immunity. (1,Table 1)

Table 1. Vaccination Rates Among US adults 2015
Table 1. Vaccination Coverage 2020 Goals for US
Table 1. Children receiving 1 doses of MMR vaccine by age 12–15 months (percent) Year 2017
Children receiving 2 doses of MMR vaccine by 4-6 years Year 2017

Vaccine	Age (years)	2015 Coverage rate(%)	2020 goal (%)
Pneumococcal	65+	61.3	90
Tdap	18+	20.1	90

Hepatitis A	18+	9	NOT SET
Hepatitis B	18+	24.5	90
Herpes zoster	60+	27.5	30
HPV	Females 18–26	40.2	80
HPV	Males 18–26	8.2	80
Influenza	18+	39	70
Influenza HCP	--	62	90

Children 2017
MMR12-15 mos.(2016)91.195
MMR 4-6 yrs(2016)90.895
1 HCP, health care personnel; HPV, human papillomavirus; Tdap, tetanus, diphtheria, pertussis.^{29,30,31}

Non-Medical Exemption

Non-Medical exemption (NME) allowances by states have contributed to low vaccination rates. According to the 2015 National Immunization Survey, only 72% of children aged 19 to 35 months in the US were fully vaccinated as per guidelines of the Advisory Committee on Immunization Practices, due to parental concerns about vaccine safety and efficacy. Many families choose to opt out their children from vaccinations required for school entry by obtaining NMEs based on religious or philosophical beliefs. Since 2009 the number of “philosophical belief” NMEs has risen in 12 of 18 states that currently allow the policy.¹ Review of federal and state Constitutional laws find that religious and personal belief exemptions to school-entry vaccine mandates are not constitutionally required.³² The legal justification for mandatory vaccination policy was announced in 1905 us Supreme Court case of Jacobson v. Massachusetts. The Supreme court determined that the government has the authority to restrict the liberty of adult citizens by compelling vaccination in order to prevent the spread of life-threatening contagious disease. This law is still in force today.³²

In the US there are three types of legal exemptions to vaccination requirements: medical exemptions, religious exemptions, and personal belief or philosophical exemptions. All states allow some type of vaccine exemption if parents can provide certification from a licensed practitioner documenting medical contraindication for specific vaccines.³²

All states allow religious exemption except for Mississippi, West Virginia, and California. Unfortunately, states have had additional legislative developments to allow greater protection for religious exemption. In most of the religious exemption states, parents simply check a box on an exemption request form. Since October 2017, seventeen states allow “philosophical” or “personal belief” exemptions which do not have to be religiously based. These exemptions have become known as “exemptions of convenience” as it is easier for parents to check a box than to obtain the immunizations. Oregon and Washington have restricted philosophical exemptions due to high non-vaccination rates.³²

Olive et al analyzed the relationship between NME and vaccine coverage. They found an inverse association between NME rate and measles, mumps, rubella (MMR) vaccine coverage of kindergarteners in these states. This shows that states with higher overall NME rates have lower MMR vaccine coverage and state closure of NMEs has resulted in an increase of MMR coverage.³³

Strict policy changes have resulted in significant reduction in NME rates. Philosophical-belief NME prohibitions proved to be an effective policy intervention in some states. Other states have attempted to decrease the NME rate through less stringent means. Currently there are ongoing policy debates at the state and national level, regarding legislation around NME for childhood vaccination. There is also a special government commission on vaccine safety which may affect vaccine coverage in the future.¹

Children

Identifying what causes parents and caregivers to refuse or skip vaccinating their children is essential to develop strategies to improve vaccination coverage.³⁴ The CDC recommends physicians ask about vaccination status at each visit, make a strong recommendation and ensure patients know the potential consequences of not protecting themselves.¹⁶

Lack of recommended scheduled Immunizations to children due to inadequate public awareness, limited appreciation of the importance of beginning immunization at infancy and immunizing children at recommended ages, are major factors in the resurgence of a previously eradicated disease. Increasingly, American parents reject universally recommended immunizations citing concerns

about the missing, conflicting, changing or otherwise unreliable nature of information.^{35,18}

Blaisdell et al³⁵ cites a demographic study showing that these parents can be placed in one of the following two groups: the vaccine refusers and vaccine hesitators. The study population was 42 English-speaking parents of children age 0 to 8 years from the greater Portland, Maine area. The participants were given a financial incentive to participate.

Vaccine-refusal parents

Parents who refuse immunization for their children are often influenced by misleading information of vaccine risks found on the internet and in the media, such as allergic reactions or Autism.³⁵ In reality, severe allergic reactions occur one in one million doses.⁹ A retrospective study found no link between the MMR vaccine and autism disorders, and that the decrease in MMR vaccination (or even withdrawal) did not influence the rate of autism.³⁶

Vaccine-hesitant parents

Vaccine hesitancy is defined as a delay or refusal to accept vaccination based on personal beliefs despite availability.¹ It is influenced by complacency, convenience and lack of confidence in vaccines.³⁶ It has been identified as a variety of behavioral responses including refusal, delay, and alternative schedules. These parents are more likely to be white, married and of higher education and income, subscribe to natural parenting or natural living philosophies. They live in states that allow philosophical exemption from school immunization laws.³⁵ State policy allows parents to opt out of the mandatory immunizations for school for religious, medical and in 19 states, philosophical reasons.³⁴ This group believes that getting the natural disease is healthier and that multiple vaccines are unhealthy for the immune system. They also feel vaccine preventable disease risk is minimal, vaccines are harmful to children and that unvaccinated children are protected by vaccinated children.³⁵ These parents believe that the safety of vaccines is uncertain; providers are undereducated about vaccine safety issues and that government and pharmaceutical industries are not trustworthy. They describe clinicians as “rank and file” providers who blindly follow government recommendations that are ultimately motivated by the pharmaceutical industry. This group is particularly fearful of vaccine additives.³⁵

Adults

Adults cite the following reasons for immunization refusal:

1. It is inconvenient to make time for appointments.
2. Vaccines lack evidence of effectiveness.
3. Vaccines are potentially risky.

Reyna et al³⁶ researched the perception of aversion to ambiguity in medical decision making. Their study found that when risks are perceived as unknown (stemming from the incomplete, conflicting, and changing information people are exposed to via the internet, social networks and friends/personal narratives) people will form pessimistic opinions of the choice options and avoid decision making.^{36,35} The Adult vaccine candidate who hesitates or refuses vaccination can be placed in one of the below categories.³⁶

Cognitive biases in vaccine decisions

Omission bias: These people choose a potentially harmful inaction to a potentially less harmful act. (They are willing to suffer longer from symptoms caused by a disease than a reaction to a vaccine).^{36,4}

Ambiguity aversion: These people find risks from known disease more acceptable than the less (but perceived ambiguous) risks from vaccine. Ambiguity results from conflicting information about immunization risks and leads to inaction, skepticism of medical information on risks and benefits of vaccines, exaggeration of vulnerability to side effects and anxiety. Anti-vaccine activists and media coverage of rare adverse reactions offer a frightening message about risks which is easily remembered during the decision process.³⁶

Present bias: These people put more weight on costs and benefits for today and less weight on benefits for the future. (They prefer lack of potential side effects of the vaccine now, to lack of illness in the future).³⁶

Optimism bias: Also known as the “Unaware/Unbelieving” patient. These people believe it is a greater health risk for others than themselves. They estimate their susceptibility to disease to be much lower than others. They prefer natural products or substances that are less effective, or even harmful, because they

are not “synthetic”. They are more biased against harmful acts like vaccination as opposed to harmful omission.³⁶ This group does not believe in the effectiveness of vaccines and disagrees with recommendations for vaccination. They argue that the preventable illnesses are not as prevalent or as severe as depicted in vaccine promotion materials. “I do not need vaccines for diseases that are not common anymore”. Mismatches between flu strains and flu vaccines support their belief of only partial and short-term immunity during flu season.^{36,34}

Unmotivated: This group is also known as the “Unconcerned” patient. They fear side effects and long-term complications. They have a fear of needles and a general dislike of medications.^{36,2,34} They have issues of complacency (insufficiently valuing vaccines or the need to become vaccinated); and feel vaccination stations/opportunities are not readily available or convenient.^{36,34}

Health Care workers.

All health care workers have taken the oath to “do no harm” and need to set a good example of disease prevention for the public. Unvaccinated health care workers are determined to be a clear and present danger to the health of others. For example, Influenza is contagious for 4 days before symptoms appear; yet 86% of health care workers report they have worked despite having flu like symptoms.³⁶⁽³⁾ In 1998, only 12% of all health care workers in the ICU and 15% neonatal nurses were vaccinated against influenza.³⁶

Refusal of vaccines by health care workers feeds public distrust and fear of vaccines, reinforcing antivaccine sentiments.³⁶ Our Health care system needs enough healthy health care workers to provide treatment and should view mandating full vaccination status for health care workers as a critical necessity for controlling morbidity and mortality rates of the patients we serve.

Medical system failures

Despite awareness and access to medical care, issues with administration standards and a lack of quality measures can create missed opportunities for administering vaccines.³⁷ Studies have shown that only 1/3 of all health care visits include assessment of immunization status³⁷. Examples include:

1. Children brought to health care facility for immunization but not vaccinated due to inappropriate contraindications, such as minor illness.
2. Only one or two vaccines administered when in fact others are needed and should be given.
3. Immunization status is not assessed or offered when a patient is at a health care facility for other reasons.
4. Failure to vaccinate in ER or Urgent care facilities. This is especially important as many inner-city families use these settings as a primary source of care.
5. Public assistance programs provide opportunities to screen for immunization, but do not. These programs could provide vaccines on site as 91% of unvaccinated children are enrolled in one or more public assistance programs. Immunizations should be an integral part of the programs. Staffing should be considered to meet this need.
6. Immunization costs are a deterrent. Copays are assessed and sometimes no insurance coverage is available to offset vaccine cost. Private practices do not receive government funding and pass the high cost of vaccines onto the patient.
7. Immunizations are available by appointment only.
8. Requirement for physical exam prior to immunization.
9. Need for physician order or referral for vaccination.
10. Requirements for enrollment in well-baby clinics in order to be immunized.
11. Insufficient clinic personnel, inadequate clinic hours (lack of evening and weekend hours), and locations.
12. Lack of culturally sensitive and linguistically appropriate health education materials.
13. Inability to track or notify families when vaccines are due.
14. Lack of medical relationships. Long term patient/medical provider relationships have suffered over the years due to the higher mobility and general busyness of the American family. Many families no longer develop relationships with a healthcare provider due to use of Minute clinics and Emergency rooms.^{36,34}

rates increased from 30 to 98.9%.³⁶. Measles antibody status should also be assessed prior to employment and immunization required if serum antibodies are negative.

All health care workers now have the ability to practice at the top of their license to allow increased opportunity to provide immunizations. Currently the Center for Disease control has developed standing orders for pharmacists and nurses to provide immunizations within their scope of practice.³⁷ Blum et al reports Project IMPACT(Improving America's Communities Together) Immunizations project's primary objective was to evaluate a practice model where pharmacists have access to patients' vaccine history (IIS) at point of care. It was hypothesized that a significant percentage of people presenting to the pharmacy for an Influenza vaccination would have additional unmet vaccination needs. The pharmacist would be able to identify these needs and educate the patient at that time. Patients with those unmet needs would take advantage of the opportunity for additional vaccines. This study was performed in 8 small towns in rural Washington state during a 6-month window during 2015-2016 Influenza season. There were 1080 study patients, all over the age of 18 with an average age of 62.5 years. Of the 1080 study patients, 1566 additional vaccines were also due at the time the patient was receiving the influenza vaccine. There were 36 contraindications and 196 vaccines declined, leaving 1334 unmet vaccination needs. Of these 1334, one third were resolved during the 6-month study period. 426 (95.3%) were provided by the pharmacist at point of care and the other 4.7% were provided at a patient-initiated follow-up visit.³⁷

Use of mobile phone messaging for immunization appointment reminders. Practice websites allow ability to schedule appointments.²⁹ Medical practice sites provide extended weekday and weekend hours.

New health care practice Immunization Performance Measures in quality improvement. Provision of performance feedback to providers to incentivize them to improve immunization administration. The use of incentive programs tied to health care worker payment and bonuses.^{29,37}

Current Methods to Address Measles in the US

States mandate that influenza vaccine of health care workers is a core patient and health care provider safety practice. Work site Flu mandates now require flu vaccination as a condition of employment; otherwise employees are to wear a mask while at work for the entire flu season. As a result, Influenza vaccination

What could be done

1. Improve the availability of immunizations. Both primary and specialty providers should provide immunizations.²⁹
2. Ensure the US maintains a high 2-dose Measles vaccination coverage.¹¹
3. Reduction and monitoring rates of vaccine exemption. This

will be critical step to achieve measles elimination.

4. Continue research efforts to ensure existing vaccines continue to provide a high degree of protection.³⁶
5. Development of alternatives to syringe administration of vaccines.³¹
6. Improve the management of immunization provision through the

ongoing documentation of immunization status. All health care facilities and government assistance programs should be required to participate and submit vaccine administration records in the State immunization system (IIS) via technology interface.³⁷ ISS currently provides confidential computerized databases to allow providers an efficient way to record and access records to enable timely immunizations and enhance provider efficiency in providing immunizations.³⁷

The IIS technology should be expanded to be a National database, accessible from any state, to allow records for those patients who relocate frequently to have accurate records available. This would allow any documented vaccine to be shared with any health care provider or government assistance agency across the United States.

7. Legal consequences of unimmunized children.⁹ Those parents who decline immunizations for their children could be ineligible to claim family tax benefits. Unimmunized children would not be allowed to attend public school.³⁶
8. Strict adherence to immunization recommendations for the US traveler.
9. A committed global effort to eradicate measles. Efforts to increase immunization rates and strict adherence to CDC immunization recommendations for all international travelers, prior to travel.³¹
10. Increase public and health provider education efforts.³¹

Conclusion

Measles once eliminated in the US as of 2000 has had a resurgence and now an epidemic due to immunization aversion. This paper has examined the public health and economic consequences of declining childhood vaccination, a result of a growing vaccine hesitancy movement using the example of the MMR vaccination rates and measles virus rates.¹ Physical, cultural and religious, financial, emotional, and educational barriers influencing Immunization acceptance have been identified.

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