



## Is There a Resurgence of Vaccine Preventable Diseases in the U.S.?

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### ARTICLE INFO

#### Article history:

Received 9 August 2018

Revised 16 November 2018

Accepted 16 November 2018

#### Keywords:

Immunization

Vaccines

Parental refusal

Vaccine-preventable diseases

### ABSTRACT

Immunizations are a safe and effective means of promoting health and preventing disease. Vaccine programs prevent millions of cases of disease and save thousands of lives in the U.S. each year; however, the threat of vaccine-preventable diseases remains. Recent years have seen a resurgence in certain vaccine-preventable diseases which can be attributed to vaccine refusals, under-vaccination, waning immunity, less effective immunizations, and imported cases. Nurses must stay informed about the current state of vaccine compliance and disease resurgence in order to best educate families. Understanding why families refuse or delay vaccinations provides a basis for nurses to plan educational interventions designed to best meet the needs of each family.

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Healthy People 2020 attributes modern day life expectancy to the reduction of infectious diseases as a result of immunizations (U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion [ODPHP], 2018). Since vaccine programs began in the 1960s, incidences of vaccine-preventable diseases (VPD) have dropped dramatically (Centers for Disease Control and Prevention [CDC], 2018b). Yet, people in the U.S. continue to get VPD and 300 children die from VPD every year (ODPHP, 2018). Not only do these VPD continue to occur despite vaccinations, but there are also signs that several disease outbreaks are increasing (CDC, 2018b; Mole, 2017).

The Society of Pediatric Nurses is currently reviewing its position statement on immunizations, so a review of the current U.S. immunization and infectious disease status is timely. Looking at factors influencing the current situation and the role nurses play may be beneficial as well. A current review of literature reveals that more parents are refusing or delaying recommended immunizations for their children. At the same time, three VPD (measles, mumps, and pertussis) continue to have steady outbreaks. While immunization rates as a whole remain stable, factors influencing vaccination trends and the potential for herd immunity rates to drop bolsters the impact of disease resurgences. This article will review the current literature regarding U.S. vaccine compliance data and the three VPD with continued prevalent outbreaks. Literature regarding influencing factors leading to outbreaks, changes in vaccination practices, and how nurses can best intervene will also be discussed.

### Vaccine Compliance and Completion

Overall immunization rates in the U.S. are high, particularly in school-age children, but rates decrease with age (Ventola, 2016).

According to the CDC (2017a), for children 19 to 35 months, compliance rates for most vaccines is >90%. In this age range, only 0.8% of children received no vaccines (ODPHP, 2018). Children enrolled in kindergarten reach compliance rates with recommended vaccines of 93–95%, and even teenagers, the cohort with the lowest compliance, still complete >80% of recommended vaccines (ODPHP, 2018).

Surveillance of vaccines is monitored in the U.S. by several groups according to age and reported to the CDC which keeps track of vaccine rates for the recommended immunizations (CDC, 2016). Potential issues with surveillance are reporting bias, inconsistencies, and data lags (Bok, 2014). The Advisory Committee on Immunization Practice (ACIP) recommends vaccinations at specific ages and intervals to provide maximum effectiveness (see Table 1).

Vaccine compliance is defined as the proportion of children who receive each dose during the recommended age-appropriate window (Kurosky, Davis, & Krishnarajah, 2016). Vaccine completion is the accumulation of the required number of ACIP recommended doses by a specific age regardless of the time of vaccine administration (Kurosky et al., 2016). Under-vaccination refers to the total number of days a vaccine is delayed beyond the recommended age range (Kurosky et al., 2016). There is a concern that even though overall compliance with recommended vaccines appears high, immunization completion rates vary by antigen, age, measurement period, and geographical region leaving populations unprotected and vulnerable. A study of over 11,000 children revealed that while 70% had completed recommended vaccines by two years of age, approximately 75% did not receive all recommended doses at the appropriate times (Kurosky et al., 2016). At least one dose of vaccine was administered late in 74% of the cases. Completion rates were lowest during the ages of 8 and 18 months, with greater than seven months elapsing; leaving infants unvaccinated for at least seven months (see Tables 2 and 3). Completion was highest in Southern and Midwest states, and lowest in Western states (Kurosky et al., 2016).

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**Table 1**  
Total number of vaccine doses required by age.

Vaccine	8 months	18 months	24 months
Measles/mumps/rubella (MMR)	N/A	1 dose	1 dose
Diphtheria, tetanus, acellular pertussis (DTaP)	3 doses	4 doses	4 doses

### Resurgence of Vaccine-preventable Diseases

Until the organisms that cause infectious diseases are eradicated, VPD remain a threat. Fortunately, in the U.S., there is <1 case/million compared to 40 cases/million worldwide (Van Zelfden, 2018). Vaccine programs are successfully preventing 2–3 million deaths worldwide (World Health Organization [WHO], 2018). In the U.S., each cohort immunized saves 33,000 lives and prevents 14 million cases of disease (ODPHP, 2018). Zhou et al. (2014) reported that vaccination saves at least \$10 in direct and societal costs for every \$1 spent. Smallpox has been eradicated worldwide, and polio was eliminated from the U.S. in 1979 (The College of Physicians of Philadelphia, 2018). In 2016 there were fewer cases of paralysis in the world from polio than ever, two of the three strains of wild polio virus have been eliminated worldwide, and the wild polio virus has been restricted to only three areas: Afghanistan, Pakistan and Nigeria (WHO, 2018). Measles was also declared eliminated in the U.S. in the year 2000 (Mole, 2017). However, despite these positive outcomes, measles, mumps and pertussis cases are on the rise (Brady, 2015; Matt, 2016; Van Zelfden, 2018; Ventola, 2016). The resurgence of these diseases is attributed to parental refusal to vaccinate, under-vaccination, waning immunity, less effective vaccines, and global travel leading to imported cases (Van Zelfden, 2018; Ventola, 2016).

Parental refusal to vaccinate and under-vaccination not only decreases individual immunity to VPD, but it also affects the ability of the community at large to protect against these organisms by decreasing herd immunity (Ventola, 2016). When herd immunity is decreased, the ability to develop effective antibody responses and the non-exposure time between the wild virus and the immunization may have been altered which can affect proper immunity, leading to less effective vaccines (Gorski, 2012; Kityo et al., 2018; Ventola, 2016). Additionally, some vaccine protection wears off sooner than expected resulting in waning immunity. This is true of mumps, acellular pertussis, tetanus, and flu immunizations. These vaccines require booster doses to maintain immunity (Gorski, 2012). Although many VPD have been significantly decreased in the U.S., they are still prevalent throughout the world. The ease and frequency of world travel has increased the risk of transporting these VPD into the U.S. and transmitting them to unvaccinated and under-vaccinated individuals, and areas with low herd immunity (Richards, 2018; Welsh, 2018).

#### Measles

Between 2001 and 2015 there have been over 17,000 cases of measles in the U.S. Interestingly, only 535 of the cases were imported; meaning that most of these measles cases were acquired inside the U.S. where measles was declared eliminated (Clemmons, Wallace, & Patel, 2017). The majority of cases (70%) affected unvaccinated individuals, of those 30 years or older, 48% had unknown vaccination status (Clemmons et al., 2017). Non-medical exemptions were cited for 70%

**Table 2**  
Vaccine completion data.

Vaccine	8 months	18 months	24 months
MMR	N/A	86% (1 dose)	90% (1 dose)
DTaP	83% (3 doses)	69% (4 doses)	80% (4 doses)
Total for all doses	66–70% vaccine completion of series by 24 months		

**Table 3**  
Vaccine compliance and under-vaccination data.

Vaccine	Doses on time (compliance)	Under-vaccinated	Average # unvaccinated days
MMR	78%	11%	152
DTaP	56%	15%	214

of the nonvaccinated cases (Phadke, Bednarczyk, Salmon, & Omer, 2016). These outbreaks affected all ages from newborn to 89 years, with a median age of 15 years (Clemmons et al., 2017). Table 4 presents a breakdown of the ages and vaccination status for these outbreaks. The first nine months of 2017 revealed 120 cases of measles in 15 states (Van Zelfden, 2018). Researchers have identified geographical “hotspot” areas where claims of nonmedical exemptions are high and vaccination coverage is very low (Welsh, 2018). These areas include metropolitan clusters representing >5% of all kindergarteners in the area, and smaller rural areas containing >14% of all children enrolled in kindergarten (Welsh, 2018). Because measles is highly contagious, 90–95% immunization coverage is necessary to protect a community from a disease outbreak (Welsh, 2018). Nathan and Hotez (2017) conducted a modeling study showing that just a 5% decrease in measles vaccination coverage could triple annual measles cases. Thus, increasing numbers of unvaccinated individuals, particularly in clusters, perpetuates these persistent outbreaks and can lead to more serious trends.

#### Pertussis

Pertussis has consistently sustained outbreaks since the 1970s. There have been 32 outbreaks affecting 10,000 people from 1977 to 2015; of those affected, between 24 and 45% were unvaccinated (Phadke et al., 2016). However, two large outbreaks occurred in 2015 and 2016 affecting 20,000 and 18,000 people respectively and resulting in seven deaths (CDC, 2017b; Pratt, 2018). Most of those affected in the outbreaks were previously vaccinated children aged 7 to 10 years old (Doleny, 2018; Eshofonie, Lin, Valcin, Mortin, & Grunenwald, 2015). While refusal to vaccinate and under-vaccination contributes to these sustained outbreaks, waning immunity and ineffectiveness of the vaccine are more significant contributing factors (Rimier, 2016; Van Zelfden, 2018; Ventola, 2016).

#### Mumps

The largest outbreak of mumps in 20 years occurred in 2006 affecting 6500 cases in eight Midwestern states (Ventola, 2016). There were over 4000 mumps cases in the first nine months of 2017 (Van Zelfden, 2018). Most cases of mumps outbreaks occur in areas of dense living, and occur despite adequate vaccination coverage (Ventola, 2016). The mumps vaccine is proven to be 88% effective after two doses (Van Zelfden, 2018). Researchers began to question whether these outbreaks were the result of new strains of mumps virus or waning immunity. Studies revealed that waning immunity is the likely culprit (Harvard Chan, 2018). Research is still needed to explore immune responses of at risk populations over time and to estimate the effectiveness of the vaccine over time (Harvard Chan, 2018). Thus, the need for a routine

**Table 4**  
Age and vaccination status of measles outbreak cases.

Age	# cases	# unvaccinated	# vaccinated	# unknown
0–5 months	31	31	0	0
6–11 months	163	161	2	0
12–15 months	106	95	7	4
16 months–4 years	214	164	36	22
5–17 years	464	406	36	22
>18 years	809	385	149	275

Clemmons et al. (2017).

third dose or a more effective vaccine altogether has been debated (Harvard Chan, 2018; Van Zelfden, 2018; Ventola, 2016). A third dose of mumps vaccine is currently recommended during outbreak situations (CDC, 2018a).

### Parental Refusal to Vaccinate/Under-vaccination

According to the most recent published study, 74.5% of pediatricians reported a parent refused to vaccinate their child in the previous 12 months in 2006, while 87% of pediatricians reported a parent refused to vaccinate their child in the past year in 2013 (Hough-Telford et al., 2016). Additionally, pediatricians reported that 87% of parents requested at least one dose of vaccination be delayed. Almost one in five parents requested a delay in more than one vaccine (Hough-Telford et al., 2016).

#### Vaccines Unnecessary

The most common reason for requesting a delay in vaccination was fear of discomfort followed by too high a burden on the immune system. In 2006, the most common reason (74%) cited for refusing vaccination was fear of autism, this fear was cited for 64% of refusals in the 2013 survey (Hough-Telford et al., 2016). The most common reason parents cite in 2013 for refusing vaccines is because they believe the vaccines are not necessary. Researchers also report that parents cited a belief that VPD intended to be protected by immunizations are rare and not serious (Blaszczak-Boxe, 2016). The main viewpoint surrounding parental vaccine refusal in recent years centers more around the sociological idea that parents do not feel they are responsible for others in their community; therefore, they are not obliged to contribute to herd immunity (Blaszczak-Boxe, 2016; Miller, 2017). Additionally, these parents believe that individuals alone hold all the responsibility for their own health and society holds no responsibility at all for society's health decisions (Blaszczak-Boxe, 2016; Miller, 2017). Consequently, these parents do not believe that information about vaccines apply to their own family (Miller, 2017).

McKee and Bohannon (2016) identified four categories of vaccine refusals other than medical necessity: religious, personal/philosophical, safety concerns, and additional education.

#### Religious Exemptions

Religious exemptions can be claimed in 47 states (all states except California, Mississippi, and West Virginia) and are usually applied to all vaccines, not select series (National Conference of State Legislatures, 2017; Ventola, 2016). Areas with higher religious exemption rates tend to have higher pertussis cases (McKee & Bohannon, 2016). There has also been higher religious exemptions claimed since the inception of the HPV vaccine presumably attributed to claims of separation between church and state and moral/religious grounds associating HPV with sexual conduct (Ventola, 2016).

#### Personal/Philosophical Exemptions

Personal/philosophical exemptions include beliefs that non-vaccination will build natural immunity or a stronger immune system. Some parents think that their child is at minimal risk for contracting the vaccine-preventable diseases, either because the diseases are not prevalent, or because their family lives a healthy lifestyle (McKee & Bohannon, 2016). Also included in this category is the belief that VPD are easily treatable, so the negative side effects of immunizations outweigh the benefits (McKee & Bohannon, 2016).

#### Safety Concern Refusals

While fear about autism may not be the most commonly cited reason for refusing vaccines, it still remains a concern (McKee & Bohannon, 2016; Ventola, 2016). Fears related to autism and attention deficit hyperactivity disorder are enhanced by the internet and social media reports (McKee & Bohannon, 2016; Ventola, 2016). Additional safety concerns relate to fears of receiving the disease after vaccination, weakened immune systems, fragile or immature immune systems, and chronic illnesses (McKee & Bohannon, 2016). Parents also cite objections to children receiving large numbers of injections (Ventola, 2016). According to Matt (2016), many parents will claim religious or philosophical exemptions because they are allowed by the states, but what really exists are safety concerns requiring more information and counseling from a healthcare provider.

#### Additional Education

Parents who expressed needing additional information before deciding to vaccinate stated that they either thought vaccines were not recommended, not needed, or they did not have enough knowledge to decide (McKee & Bohannon, 2016; Ventola, 2016). Approximately one-third of parents surveyed did not have access to sufficient information and did not think their healthcare provider was easy to talk to, finding it difficult to make an informed decision (McKee & Bohannon, 2016). Parents reported they highly trusted their healthcare provider as the most important source of vaccine-related information, followed by other healthcare professionals and other government vaccine experts (Freed, Clark, Butchart, Singer, & Davis, 2011; McKee & Bohannon, 2016).

#### Implications for Nursing Practice

Research indicates that physicians and other healthcare professionals are the most important source of information for parents making decisions about vaccinations (Freed et al., 2011; McKee & Bohannon, 2016). A study comparing medical staff to the general population showed that when given both pro and con vaccine statements, both groups agreed with the positive vaccine statements and categorized pro-vaccine statements as fact (Latella, McAuley, & Rabinowitz, 2018). Findings of this study suggest that healthcare providers should focus vaccine counseling on countering parent's anti-vaccine concerns rather than pushing pro-vaccine ideas because parents already know and agree with the positive information. Parents need to feel that their fears are being acknowledged and receive answers to their concerns (Latella et al., 2018).

Research into the effects of provider communication on increasing vaccine compliance suggests that healthcare providers engaging with hesitant parents should not give in to parents wishing to refuse vaccination. Giving in results in missed educational opportunities and untimely or missed vaccinations. Instead, healthcare providers should address the concerns immediately and straight on, which can result in timely vaccination (Reno et al., 2018; Shay et al., 2018). Although hesitancy provides an opportune time to influence vaccine acceptance, dialogue should be an on-going process rather than a challenge or pressure to sway hesitant parents to vaccinate (Larson, 2013). Pressuring parents who are hesitant and still have questions can be counter-productive and could even lead to vaccine refusal. Active listening, building trust, and collaborating with the parent is key to assisting the parent to make informed decisions (Connors, Slotwinski, & Hodges, 2016; Dubé, 2016; Larson, 2013; Steffens & Tarr, 2018). Ultimately, maintaining acceptance is critical to building trust and support (Dubé, 2016). Applying strategies of motivational interviewing when communicating about vaccinations enhances the parent's own motivation to change and behavioral activation (Steffens & Tarr, 2018). Ventola (2016) suggests asking hesitant parents to sign exemption forms. Being informed and making strong

recommendations about vaccinations increases parents' trust in their healthcare provider and their understanding about the necessity for immunizations (Ventola, 2016). Finally, providers should advocate for community-based interventions that support a culture of immunization like public reminders, free vaccines, and alternate venues for easy access to all (Ventola, 2016).

There has been a trend of physicians refusing to care for families who refuse to vaccinate. One study reported as many as 40% of physicians who stopped providing care for families refusing to vaccinate (Omer, Salmon, Orenstein, deHart, & Halsey, 2009). The CDC and the American Academy of Pediatrics urge physicians not to refuse care to these families for fear that children will not receive necessary care and will fall further down the anti-vaccine hole. Instead, they recommend listening respectfully to parental concerns and discussing specific vaccines of concern, sharing information about vaccine risks and benefits, and explaining risks of non-immunization (Omer et al., 2009).

Immunizations are a safe, successful, and cost-effective method of promoting health and preventing disease. However, the threat of vaccine-preventable diseases remains due to refusal to vaccinate, waning immunity, less-effective vaccines, and imported cases. Nurses play an important role in listening to parental concerns and providing education about vaccines and risks of non-immunization. Engaging in motivational interviewing, reflecting and affirming what parents say, and accepting parental choices assists in building trust and helps parents make informed decisions.

### CRedit authorship contribution statement

**Laura Kubin:** Conceptualization, Project administration, Validation, Writing - original draft, Writing - review & editing.

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