ABSTRACT: *As the increasingly fierce debate about vaccines grows, so do the number of measles cases. Personal choice, inaccurate understanding, and legislative action are fueling vaccine refusal for this previously eradicated, highly contagious viral infection. In August 2019, measles cases had spread to 30 U.S. states and were spreading globally, endangering mainly young children and those unable to be vaccinated. Herd immunity is being eroded as parents refuse vaccinations or choose alternate vaccine schedules. Nurses are in a prime position to educate and advocate for vaccinations that safeguard public health.*

KEY WORDS: *herd immunity, infectious diseases, measles, MMR, nursing, pediatrics, rubeola, vaccination*

CE 1.5 contact hours

MEASLES AND VACCINATION

A Resurrected Disease, A Conflicted Response

BY KAREN SCHMIDT

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The author declares no conflict of interest.

Accepted by peer-review 4/29/2019.

*The patient's name has been changed to protect privacy.

DOI:10.1097/CNJ.0000000000000654

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Eight-year-old Nadia* presented at a suburban hospital emergency room on a Friday night with a fever of 103.6° F (39.7° C), cough, and rhinorrhea. Her mother said the on-call provider at their pediatrician's office recommended the Emergency Room (ER) when the 3-day fever did not subside. The mother and daughter sat in the ER waiting room for hours before seeing a triage nurse who noted Nadia shading her eyes in the exam room. When the nurse asked if others in the household had been sick, Nadia's mother said no.

On physical exam, the nurse observed atypical white grain-like spots in Nadia's mouth. She began to suspect measles. The nurse had Nadia and her mother put on masks and walked with them to the ER's isolation room. She closed the door, posted a restricted entry sign, and immediately notified the ER manager and the hospital's infectious disease control department.

When the nurse queried Nadia's mother about a vaccine history, she learned that the family believed vaccines are less important than a healthy lifestyle for preventing illness. Nadia's mother thought her daughter may have had a Measles-Mumps-Rubella (MMR) vaccine as a toddler. Vaccinations of other family members were uncertain; Nadia's 3-month-old baby brother was too young for the MMR. The mother asked where Nadia might have been exposed to measles. Through the county public health web portal, the nurse accessed a list of known local measles exposure sites, and the family acknowledged that Nadia had been to a birthday party 2 weeks before at a trampoline park where another child with a confirmed measles case had attended.

INTRODUCTION

A scenario such as Nadia's is increasingly likely across the United States as the number of measles cases rises. From January 1 to August 1, 2019, 1,172 individual cases of measles were confirmed in 30 states spanning the country—the greatest number of cases since 1992. Outbreaks in New York are linked to more than 75% of this year's cases (Centers for Disease Control and Prevention [CDC], 2019a).

Annually, measles infects up to 20 million globally. In 2016, the World Health Organization (WHO, 2019) recorded 89,780 deaths due to the virus. Cases in the United States are becoming more frequent as vaccination rates are falling and infected travelers bring the virus home. Between 2000 and 2007, the CDC received reports of about 63 cases a year. Since then, the infection rate has continued to rise annually (CDC, 2018).

IN THE MEASLES POST-ELIMINATION ERA, A SINGLE CASE OF MEASLES IS CONSIDERED A PUBLIC HEALTH PRIORITY.

Because measles is an increasing public health concern nurses need to be fluent in the signs and symptoms of measles infection, complications, communicability, and prevention. The public's changing beliefs and compliance related to childhood vaccines require that nurses stay current in their knowledge of the disease and evidence-based prevention to be able to provide effective patient education.

PATHOPHYSIOLOGY & DIAGNOSIS

Measles was first identified by Persian philosopher and physician Zakariyyā'al-Rāzī who wrote about measles in the ninth century. In 1757, Francis Home, a Scottish physician, demonstrated that measles was a respiratory infection and began experimenting with a vaccine (National Vaccine Information Center, 2019). The CDC notes that measles became a nationally notifiable disease in 1912; during the first decade of reporting, an average of 6,000 measles-related deaths were reported annually. In 2000, measles was declared eradicated in the United States as the result of effective vaccinating (CDC, 2018).

Also known as rubeola, measles is a morbillivirus in the Paramyxoviridae family; this single-stranded, enveloped RNA virus infects the respiratory tract. Highly contagious, with an average infection rate of 90% among susceptible individuals, measles is transmitted by direct contact with respiratory droplets or inhaled aerosolized airborne droplets. The virus can survive in the air for 2 hours after an infected person exhales, coughs, or sneezes.

The first symptoms to appear are fever up to 105° F (40.5° C), lethargy, photophobia, and the three C's: cough, coryza, and conjunctivitis. Koplik spots—small, bright red spots with tiny blue-white centers—appear on the mucosa inside the mouth 2 to 3 days after symptoms begin (Steichen & Dautheville, 2009). These lesions can look like grains of rice or sand. This diagnostic sign is followed by the whole-body rash that typically appears 14 days after exposure. The rash begins at the hairline and moves down the trunk to the extremities (Figure 1). Fever may spike when the rash appears, then return to normal as the rash progresses and fades, usually within days (CDC, 2018). Immunocompromised patients do not always have a rash. The incubation period is 10 to 12 days from exposure to first symptom; infected persons are contagious up to 4 days before the rash appears until 4 days after the rash's onset.

Measles can be diagnosed based on history of exposure, physical exam, and lab analysis. The CDC (2018) states that lab confirmation of infection is necessary for all measles cases, recommending a throat swab and a serum sample of suspected cases at the first contact. Immunoglobulin M (IgM) and Immunoglobulin G (IgG) antibodies are detectable in blood serum within a few days of the rash's onset. In 90% of measles infections, an ELISA (enzyme-linked immunosorbent assay) IgM assay will be positive at 3 days after the rash onset (WHO, 2018).

Where measles is not a public health concern, misdiagnosis could occur during the prodromal phase before the rash appears because symptoms are common to general upper respiratory infections.

FIGURE 1. *Child with Measles Rash*

Measles should be considered when a patient or family member has traveled internationally within 2 weeks of infection, and with immigrant populations where vaccination rates are low or unknown (Heavey & Peterson, 2019).

Healthcare providers, and staff at hospitals, laboratories, schools, and childcare facilities must report suspected and confirmed measles cases to local or state health departments within 24 hours. Immediate reporting is necessary to limit the spread of the virus. "In the measles post-elimination era, a single case of measles is considered a public health priority that requires rapid evaluation for likelihood of measles and appropriate public health response" (CDC, 2018, p. 12).

MEASLES TREATMENT AND COMPLICATIONS

Inpatient treatment requires airborne precautions and isolation, preferably in a single-patient airborne infection isolation room, until 5 days after the rash appeared. Healthcare staff must use an N95 respirator; the CDC recommends staff without documented measles immunity avoid contact with infected persons until 21 days after onset of the rash (CDC, 2019b).

Treatment includes symptom management: bedrest, acetaminophen or ibuprofen for fever reduction in patients older than 6 months, and hydration. Dimmed lighting can reduce discomfort from photosensitivity (Heavey & Peterson, 2009). The WHO (2009) recommends vitamin A administration for severely infected pediatric patients on the day of and the day after diagnosis because vitamin A deficiency can delay recovery or increase the risk of complications.

Outpatient treatment requires vigorous instruction regarding the necessity of self-quarantine until at least 4 days after the rash disappears. All family members and others exposed to a person with measles should self-quarantine for at least 10 days. Nurses should explain how the infection is spread and list early signs and symptoms. Strongly urge each susceptible individual to be vaccinated or receive immunoglobulin, unless contraindicated.

Measles infection is most likely to result in a complication for children under age 5 and adults over age 20 (CDC, 2019b). Otitis media, a common complication occurring in 1 of 10 children, may lead to permanent hearing loss. Diarrhea is the next most common complication, affecting fewer than 1 in 10 measles patients.

Pneumonia and encephalitis are more serious complications. One in 20 children with measles may acquire pneumonia, whereas one to three of 1,000 pediatric measles patients will suffer with encephalitis. This illness may lead to deafness or cognitive disability. A child with encephalitis may present with headache, fever, and altered level of consciousness (Fisher, Defres, & Solomon, 2014).

VACCINE'S ADVENT AND CURRENT USE

Measles was a common illness among children in the United States until 1963 when the first vaccine was released. At that time, most children suffered from the virus by age 15. An estimated 3 to 4 million people in the United States had measles each year and an estimated 400 to 500 died annually (CDC, 2019c).

The MMR formulation currently in use was licensed in 1968. The vaccine combination immunizes against measles, mumps, and rubella (German measles). The CDC's current vaccination schedule for children starts with one dose at age 12 to 15 months, with a second dose between ages 4 and 6. The second dose may be given earlier, as long as 28 days have passed since the first vaccination (Table 1). The CDC states that a single dose of MMR is 93% effective for preventing measles, whereas two doses convey 97% effectiveness. Another formulation includes the varicella vaccine—MMRV—and is used only for children between ages 1 and 12 years. Both the MMR and MMRV contain live, attenuated (weakened) viruses.

Students in post high school educational settings should receive a two-dose vaccine series. If a pregnant woman has had measles or the vaccine, her baby is considered to have immunity through antibodies received in utero. Adults may choose to have a single MMR dose or to have their blood tested for the IgG titer to determine if they have had measles or been vaccinated previously, before traveling internationally. This also is the approach for a woman who is planning to become pregnant, and for healthcare workers.

The CDC (2018) lists these common side effects of the MMR vaccine: injection site soreness or redness, a mild rash, fever, and swollen glands in the cheeks or neck. These side effects may begin up to 2 weeks after vaccine

administration and are less likely after the second dose of MMR. Short-term joint pain and stiffness may affect teenage and adult women who had no previous immunity to the vaccine's rubella component (CDC, 2018). The risk of febrile seizures is very small and does not convey long-term issues. Risk of febrile seizures increases with an infant's age, so vaccination at an earlier age is preferable.

Nurses and other healthcare workers often are required to prove measles immunity or vaccination due to a higher potential of exposure than in the general adult population. Proof of immunity can include a written record of two MMR doses administered 28 or more days apart; laboratory evidence of immunity (IgG titer); lab confirmation of disease; or birth before 1957. People born before 1957 are considered immune because most would have had the virus before the first measles vaccine came into use in 1963.

If exposed to measles, a healthcare worker without evidence of immunity should receive the MMR vaccine within 72 hours or the immunoglobulin within 6 days. The CDC recommends that healthcare workers who cannot prove immunity remain off work from day 5 after first exposure to day 21 after last exposure, even if they received the vaccine after exposure. Individuals with HIV infection may be vaccinated with MMR if they do not have evidence of severe immunosuppression (CDC, 2018).

TIGHTENING LAWS ON VACCINATIONS

The 2017 National Immunization Survey-Child (NIDS-Child) reported vaccine coverage for children between 19 and 35 months of age was 90% for one dose of MMR vaccine. However, the proportion of children who had received no vaccine of any type by age 24 months climbed from 0.3% for children aged 19 to 35 months when surveyed in 2001, to 1.3% for children born in 2015. Coverage was lowest among uninsured and Medicaid-insured children and those living in rural areas (Hill, Elam-Evans, Yankey, Singleton, & Kang, 2018).

State laws mandate childhood vaccinations to varying degrees, with public schools requiring updated vaccination records for children grades K-12. Students who are not current may be excluded from school until they comply. In most states, parents can opt out of vaccinations based on religious or medical reasons, as described in the Sidebar on vaccine hesitancy. Children with immunosuppression, or those with a serious reaction to a previous vaccine, can claim a medical exemption. Some state laws allow a personal or conscientious reason for refusal. A 2016 study on religious exceptions to vaccination did not pinpoint any religious affiliation that prohibits vaccines (Pelčić et al., 2016) but observed that religious exemptions are increasing and being used more often by parents to avoid their children's vaccination.

To counter the increasing avoidance of vaccination, states are changing laws, often removing the religious or personal exemption. As of June 20, 2019, 19 states were changing or creating laws tightening exemptions, increasing reporting, or adding vaccine requirements for college students (Iannelli, 2019). New Jersey requires a religious authority (ordained or commissioned clergy) to acknowledge parents' religious exemptions, and Oregon mandates that parents provide a healthcare provider's signature stating the parents completed an educational course on vaccines. The 2019 measles epidemic in southwestern Washington resulted in a law that removes the personal exemption for the MMR

TABLE 1.
Measles, Mumps, and Rubella Vaccination Schedule

Minimum age: 12 months for routine vaccination		
Schedule:		
First of two doses at 12 to 15 months	Second dose at 4 to 6 years	Dose 2 may be administered as early as 4 weeks after dose 1.

Source: CDC (2019e). Used with permission.

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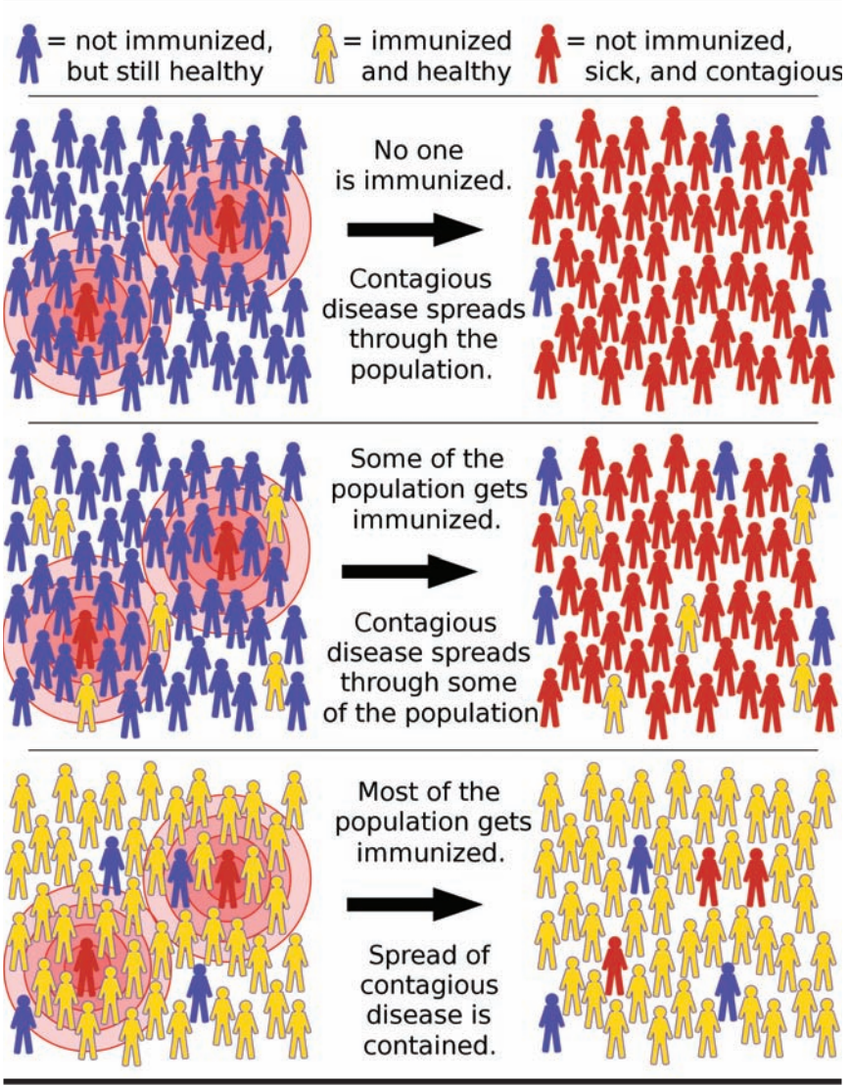
(Washington State Department of Health, 2019). The majority of children who contracted measles in Washington were unvaccinated (CDC, 2019a).

In May 2019, a study evaluating results of the elimination of nonmedical vaccine exemptions in California that took effect in 2016 revealed an increase in the number of students being vaccinated for all required vaccines following the repeal—including a 2.5% increase for the MMR vaccine (Richwine, Dor, & Moghtaderi, 2019). Nonmedical exemptions decreased by 3.4 percentage points, whereas medical exemptions increased 2.1 percentage points in counties with previously high rates of nonmedical waivers. The study concluded that the exemption repeal was only partially effective.

THE BLESSING OF HERD IMMUNITY

When vaccination rates in the United States were high, even those who had not received the MMR vaccine were much less likely to contract the virus, thanks to *herd immunity*. Also called *community immunity*, the term expresses how the spread of a disease is less likely when a threshold of 93% to 95% of members are immune to the disease (through past illness or vaccination). Through herd immunity, newborns and others who cannot be vaccinated (due to allergy to vaccine components, immunosuppression, or chronic condition) are largely protected (Boyd, 2016), as shown in Figure 2. When the United States declared measles eliminated in 2000, more than 90% of school-age children had been vaccinated against the virus (Funk, 2017). The American Academy of Pediatrics considers herd immunity essential because vulnerable populations—pregnant women, babies, and immune-compromised people who cannot be vaccinated—are protected.

FIGURE 2. *Herd Immunity*



Source: Karcher (2017) based on an illustration by the National Institute of Allergy and Infectious Diseases. Used with permission. CC BY-SA 4.0

NURSING'S ROLE IN VACCINATION

A nurse's factual, encouraging conversation with parents can be a deciding factor in whether or not a child receives needed vaccines. Through this conversation, seek to build trust with the parent; use nonjudgmental language and nonverbal communication to demonstrate your interest in the well-being of the child. Take as long as needed to present information, answer questions, and discern reasons for hesitation or reluctance. Listen receptively to the parent's concerns and answer each question clearly and factually.

A nurse's approachable, patient-centered concern that addresses fears and questions proved worthwhile in New York during the 2018–19 outbreak that largely affected the Orthodox Jewish community. Oncology nurse practitioner Blima Marcus, an Orthodox Jew herself, initiated workshops and a science-backed, fact-filled booklet to counter antivaccine beliefs. Parents have been receptive; some initiated vaccinations for their families (McKay & West, 2019).

Teach patients how vaccines work in the body to prevent infection. Explain that when a bacteria or virus enters a person's body, the person's immune system attacks those germs, so infection doesn't occur. When the body lacks immunity to bacteria or viruses, such as the measles virus, the infection causes illness.

Present objective scientific information about how a vaccine works by creating immunity in one's body by imitating the virus, so the body can

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HERD IMMUNITY IS ESSENTIAL BECAUSE VULNERABLE POPULATIONS—PREGNANT WOMEN, BABIES, AND IMMUNE-COMPROMISED PEOPLE WHO CANNOT BE VACCINATED—ARE PROTECTED.

build up an immune reaction that fights off the infection. The measles vaccine does not give a person measles; it stimulates the body's natural immune response so that when an actual infection threatens, the body repels it using the built-up immunity.

Explain to parents that the amount of antigen in a vaccine injection—the parts of germs that cause the immune system to react—is very small. Babies and children, as well as adults, react to antigens every day in their natural environment. However, illnesses like measles and other preventable infections are not present in the everyday environment so one's body cannot develop immunity to fend off that type of illness.

Discussion with parents includes *risk communication*, in which nurses educate patients about the seriousness of diseases like measles and the low risks of vaccination (ANA, n.d.). State the communicability of infectious diseases, such as measles, and share information about possible vaccine side effects and how to manage effects. Assure

SIDEBAR: WHAT IS VACCINE HESITANCY?

Vaccine hesitancy—refusing or delaying vaccination of oneself or one's children—is the chief reason for the resurgence of measles in the United States and responsible for the 30% increase in measles globally (WHO, 2019). This strengthening resistance to vaccinations is one of the WHO's 10 threats to global health in 2019.

McKee and Bohannon (2016) summarized four categories of reasons why parents are increasingly less likely to have children vaccinated: religious beliefs; personal or philosophical reasons; safety; and desire for more information. Some parents delay vaccinations or choose to space out the shots, or to allow certain vaccines but not others. Vaccine decisions also are based on the perception of a low risk of exposure to a vaccine-preventable disease, lack of awareness of the disease's potential severity, belief that natural immunity is sufficient, and/or lack of confidence in scientific evidence related to vaccine safety (Feemster, 2016). The greatest reason for parents' refusal to vaccinate is concern about the safety of vaccines, including short- and long-term side effects. Parents refusing vaccinations for safety reasons generally cite media reports or information from other people as their sources of safety concerns.

Rachel Orscheln, an infectious disease physician at St. Louis Children's Hospital in Missouri, believes that as a result of lowered rates over past decades of vaccine-preventable diseases, "Today's parents are no longer aware of the serious nature of these diseases. Their fear has shifted from their child contracting an infectious disease to fear of the vaccine" (Children's Hospital, St. Louis, 2019, para 2).

Although there is no documented reason for religious exemption, cultural influences are detrimentally affecting vaccination rates in the United States. In 2017, a measles outbreak in Minnesota largely affected children of Somali immigrants. Haston and Pickering (2018) reported that a study of Minnesota state vaccination registries showed that children with at least one foreign-born parent were less likely to have received all recommended vaccines up to 36 months of age, as compared with children of two United States-born parents. Ten percent (10%) of children with Somali mothers were up to date on vaccines at age 18 months, and 44% by age 36 months.

In the United States, ultra-orthodox Jewish communities, in which vaccination is sometimes opposed, especially in Brooklyn and the Hudson Valley of New York, have seen more than 170 Jewish people become infected in the current 2019 measles outbreak. However, most major orthodox institutions or yeshivas (religious schools) do require vaccinations, but some allow parents to make the decision; a 60% vaccination rate is common among New York yeshivas. Jewish Talmudic law imperative, *pikuach nefesh*, which means "saving a life," ethically requires all to be vaccinated to prevent disease in the community (Feldman, 2019). The CDC (2019d) advises travelers to Israel, where there also is a current measles outbreak, to have proof of measles immunity; the CDC recommends revaccination with one dose of MMR, especially for those with only one dose, and infants under 12 months, who normally would not yet have the vaccine.

Some Christians oppose vaccination related to the pro-life cause, dating back to the 1960s when measles was common, and a scientist used lung cells from an aborted fetus to isolate a cell strain used to make vaccines. Only cells from that original fetus and one other aborted embryo are used to create *today's* vaccines; no new fetal cells are used for vaccine production (Goins-Philips, 2019).

No Autism Connection. Belief that the MMR vaccine can increase the risk of autism has frightened parents since 1998 when *The Lancet* published a study (since retracted) claiming a link between autism and the MMR vaccine.

Various studies have failed to prove a link between the MMR vaccine and autism. A 2019 study in Denmark of 657,461 children born between 1999 and 2010 (using population registries) led researchers to "strongly support that MMR vaccination does not increase the risk for autism, does not trigger autism in susceptible children, and is not associated with clustering of autism cases after vaccination" (Hviid, Hansen, Frisch, & Melbye, 2019, p. 513). A study released in 2015 also concluded that receiving an MMR vaccine did not increase the risk of autism spectrum disorder (ASD), including for children with older siblings who had ASD (Jain et al., 2015).

Fear of components of the MMR vaccine, particularly the preservative thimerosal, has also not been substantiated with evidence. The American Academy of Pediatrics states that thimerosal has never been an ingredient in a live measles vaccine (Meissner, 2017).

Alternate Vaccination Schedules. Parents concerned about their babies receiving too many vaccines at one time often ask their healthcare provider to space out the vaccine schedule. A Missouri Department of Health presentation (Feemster, 2016) noted that more than 90% of providers are asked by parents to spread out vaccines; not all comply. In the United States, no official group endorses an alternate vaccination schedule, though individual providers may work with families to do so (Meissner, 2017).

An alternate schedule often referred to by proponents of spacing out vaccinations is *The Vaccine Book: Making the Right Decision for Your Child* by Robert Sears (2011). However, delaying vaccines does not benefit children, but instead increases their risk of contracting a preventable disease (Meissner, 2017). A risk of spacing out the vaccinations is that children will not receive all the shots needed due to the extended time span or the inconvenience of many doctor visits, thus increasing children's risk of illness.

Nursing's Stance. The American Nurses Association (ANA) "has strongly supported immunizations to protect the public from highly communicable and deadly diseases such as measles, mumps, diphtheria, pertussis, and influenza" (ANA, 2015, p. 1). In addition to the ANA's position on vaccination of healthcare professionals, the ANA Immunize website shares patient education information, clinical tools, safety, and research topics (see Web Resources).

parents that the safety of vaccines is constantly monitored through the Vaccine Adverse Event Reporting System (VAERS, n.d.), a national system that keeps a sharp surveillance on possible safety problems with vaccines manufactured in the United States. Anyone can report side effects to a vaccine; VAERS is required to investigate every report.

Parents' fears about vaccination sometimes include the components of vaccines. Assure parents that no preservative is used in childhood vaccines except the multidose vials of influenza vaccine. Single-dose vials contain no preservative.

WHAT NEXT?

Providing accurate information to parents and the public about vaccine-preventable diseases and the reasons for receiving vaccines based on the CDC schedule are tools for nurses to wield powerfully and often. Because the American public considers nurses and healthcare providers in general to be among the most trustworthy authorities, nurses must stay current on vaccine information, including risks and benefits. Although nurses may have personal beliefs about the need for or safety of vaccines, those beliefs must be held apart from nursing professional practice.

The heated discourse about vaccinations offers Christian nurses the opportunity to bring truth and diplomacy to the table with the aim of facilitating peaceful discussion, while caring for the health of each person in the nurse's sphere of influence. Providing professional knowledge with genuine, Christ-like compassion and grace can engender peace as nurses use godly wisdom: "But the wisdom from above is first pure, then peaceable, gentle, open to reason, full of mercy and good fruits, impartial and sincere" (James 3:17, ESV).

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Web Resources

- **American Nurses Association**—https://www.nursingworld.org/practice-policy/work-environment/health-safety/immunize/
- **Arizona Department of Health Services Measles Surveillance Toolkit for Healthcare Settings**—https://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/measles/measles-surveillance-toolkit.pdf
- **Centers for Disease Control and Prevention**—https://www.cdc.gov/vaccines/index.html
- **Children's Hospital of Pennsylvania Vaccine Webinar Series**— https://www.chop.edu/centers-programs/vaccine-update/vaccine-webinar-series
- **Immunization Action Coalition**—http://immunize.org/
- **U.S. Food and Drug Administration Vaccine Adverse Events**—https://www.fda.gov/biologicsbloodvaccines/safetyavailability/reportaproblem/vaccineadverseevents/default.htm
- **You Call the Shots Web-Based Vaccine Training**—https://www.cdc.gov/vaccines/ed/youcall-theshots.html

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Disclosure Statement: The authors and planners have disclosed that they have no financial relationships related to this article.

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