Abstract: Current vaccination rates are falling with a new group of unimmunized children. Since some parents are unaware of the diseases and potential health threats, many are often influenced by the media and myths, choosing to delay or avoid vaccinations. NP providers must be prepared to confront these myths with facts to help parents make informed decisions. Vaccine-preventable diseases, popular myths, and evidence-based research findings are reviewed in this manuscript.

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Well-meaning, uninformed parents who choose not to vaccinate their children may actually be posing health risks to their children and the community. Increased media reports that focus on vaccine ingredients and possible adverse outcomes have discouraged many parents regarding early childhood vaccinations. Vaccinations not only protect children but the public health as well.1 Healthy People 2020 has set the target for childhood immunizations at 90%.2 Current vaccination rates for children ages 19 to 35 months are 76.1% fully vaccinated and 0.6% completely unvaccinated.3 Historically, immunizations have prevented and, in some cases, eradicated many devastating diseases. Parents of young children have not witnessed first-hand the devastating effects of the communicable diseases that childhood vaccines prevent. Many practitioners in active practice have not treated children with diphtheria, pertussis, measles, mumps, or rubella.4 A literature search of PubMed, CINAHL, and Medline focused on immunization refusal, parental fear, and undervaccinated yielded many articles. A lack of research was identified in children who were unvaccinated. Literature during the past decade was selected for review.

Media misinformation
According to the Pew Research Center 60% of adults regularly consult the Internet for medical information.5 An Internet search using the terms “vaccines” and “dangerous” revealed more than 100,000 antivaccine sites. Initially considered a landmark study, Lancet6 reported that the measles, mumps, and rubella (MMR) vaccine triggered intestinal inflammation that subsequently allowed harmful proteins to escape to
the brain, causing autism. Although later discredited and retracted, this study sparked an antivaccine movement that continues today. In 1999, the American Academy of Pediatrics issued warnings regarding thimerosal, a preservative used in some vaccines. Although no evidence of harm was found, thimerosal contains 49.6% ethyl mercury exceeding federal guidelines. Thimerosal was not in MMR but was an ingredient found in other vaccines such as diphtheria, tetanus, and pertussis (DTaP), *Haemophilus influenzae* type B (Hib), and influenza vaccines. By 2003, thimerosal was removed from all US vaccines, except influenza. After examining the results of more than 200 independent studies, in 2004, the Institute of Medicine formally rejected the autism vaccine link. It was also noted that symptoms usually appear around the same time that children receive the MMR vaccine and that any link is coincidental.

In 2007, one actress and model stated her belief that childhood vaccinations may have contributed to her son’s autism. When asked about current research refuting any link between autism and vaccines, she said that her science was her son. These media news stories are more readily absorbed than scientific research by some parents who worry that vaccines may not be safe for their children.

The latest vaccine to inspire controversy is the Gardasil vaccine, which is given to females 9 through 26 years to protect them against some strains of the human papillomavirus (HPV). It is also indicated in males 9 through 26 years for the prevention of anal cancer and genital warts caused by some strains of HPV. The media reported that Gardasil was responsible for 27 deaths in 2008; however, each was investigated and found to be unrelated to the vaccine Gardasil. Other reports linked Gardasil to an increased incidence of Guillain-Barré syndrome. The Vaccine Adverse Events Reporting System investigated and found no increase of Guillain-Barré syndrome above what is normally found in the population.

**Healthy People 2020, herd immunity, and outbreaks**

Healthy People 2020 has set the target for childhood immunizations at 90%. Childhood immunizations have prevented and in some cases, eradicated many devastating diseases. Because vaccines are not 100% effective, the rationale for vaccinating everyone is to avoid spread of vaccine-preventable diseases. Vaccination rates of 90% are generally sufficient to prevent the spread of communicable disease, which is known as "herd immunity." An unvaccinated group places an entire community at risk during an outbreak.

The United States suffered a measles outbreak of 131 cases in 2008; its rapid spread was attributed to unvaccinated children. A long-term study examining children in Colorado that contracted measles from 1987 to 1998 found that unvaccinated children were 22 times more likely to become infected with measles than vaccinated children, with the outbreaks beginning in clusters of unvaccinated children. Research in this area is limited.

**Parental characteristics and regional data**

Available data indicate parents of unvaccinated children tend to be White, with the mother over 30 years of age in a household with an annual income exceeding $75,000. Of parents who refused vaccines, 47.5% expressed concern about vaccine safety. More than 70% of the unvaccinated group stated that their healthcare provider was not influential in their decision to forgo vaccinations. Khalil and Caplan report that home-schooled children are frequently unvaccinated because state mandates for immunizations are linked to school attendance. Some faith communities are largely unvaccinated with the last two polio outbreaks reported among these communities in 1972 [Christian Scientists] and 1979 [Amish] and a rubella outbreak [Amish, 1991] with 890 recorded cases and approximately 12 children with lasting deformities.

Undervaccinated children are a widely researched group. This demographic tends to be Black, single mothers, who may lack knowledge of the vaccination schedule. Chu et al found that multiple children under age 18 and single motherhood predicted significant delays in vaccination.

Hispanic families tend to remain current with immunizations. It is thought that the Hispanic culture’s emphasis on the well-being of their children support this finding. Additional research on the Hispanic population and their tendency to maintain high immunization levels is needed.

Regionally, the unvaccinated tend to be grouped together. States with the highest level of unvaccinated children are Utah, Montana, Oregon, Colorado, Washington, Alaska, and Idaho. Individual counties with the highest level of unvaccinated children were all located in California. Seventeen states allow philosophical exemptions permitting parents to cite religious and personal values as reasons their children are not vaccinated before entering school. West Virginia, Mississippi, and Arkansas do not allow religious exemption. Omer analyzed data from states permitting nonmedical exemptions to vaccines and discovered the rates of nonmedical (that is, philosophical or personal) exemptions were higher than religious exemptions. States with easy exemptions, a form with parental signature, demonstrated a 5% increase in unvaccinated rate annually from 1991 to 2004. Easy exemption was also associated with increased pertussis incidence.

**Communicable diseases: An existing threat**

Immunizations are the greatest success story in public health. Because of the success of vaccines, most of the
is unaware of the devastation caused by infectious diseases. Vaccines are the best protection we have against infectious diseases. Communicable diseases continue to be an existing threat, particularly where there are pockets of under immunized members of a community. A review of vaccine-preventable childhood diseases may influence immunization decisions. Reminding parents of the seriousness of these diseases may also increase vaccination rates (see Vaccine-preventable communicable disease). Current guidelines for vaccination in the first year of life include hepatitis B, rotavirus, DTaP, Hib, Pneumococcal (PCV), inactivated polio (IPV), influenza (seasonal), MMR, varicella, and hepatitis A. The website http://www.CDC.gov contains the most current vaccination recommendation schedules.

### Vaccine-preventable communicable diseases

<table>
<thead>
<tr>
<th>Causative organism</th>
<th>Transmission</th>
<th>Signs &amp; symptoms</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis B</td>
<td>Sexual contact, infected blood and body fluids</td>
<td>Anorexia, abdominal pain, nausea, vomiting, arthralgia, rash, jaundice</td>
<td>Cirrhosis or hepatocellular carcinoma</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>Contaminated hands/objects</td>
<td>Diarrhea, fever, dehydration</td>
<td>Severe dehydration requiring hospitalization</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>Person-person intimate respiratory and physical contact</td>
<td>Sore throat, low-grade fever, adherent membrane of the tonsils, pharynx, or nose</td>
<td>Tracheal airway obstruction, myocarditis, heart block, heart failure, chronic neuropathies, 10% to 15% mortality</td>
</tr>
<tr>
<td>Tetanus</td>
<td>Deep-puncture wounds or cuts</td>
<td>Lockjaw, neck stiffness and abdomen stiffness, difficulty swallowing</td>
<td>Severe muscle spasms, generalized clonic seizures, autonomic nervous system disorders, cardiac dysrhythmias, bone fractures</td>
</tr>
<tr>
<td>Pertussis</td>
<td>Respiratory droplets</td>
<td>Irritating cough that becomes spastic &amp; violent, 100-day cough</td>
<td>Pneumonia, atelectasia, seizures, encephalopathy, hernia, death from complications of pneumonia</td>
</tr>
<tr>
<td>Hib</td>
<td>Respiratory droplets</td>
<td>Occult febrile bacteremia, otitis media, cellulitis</td>
<td>Bacterial meningitis, Epiglottis, pneumonia, mental retardation, hearing loss, and loss of limb use, sepsis, mortality 50%</td>
</tr>
<tr>
<td>Pneumococcal</td>
<td>Respiratory droplets</td>
<td>High fever, dyspnea, bacteremia,</td>
<td>Meningitis, mortality of 5% to 10% affecting mostly infants and elders, community-acquired pneumonia</td>
</tr>
<tr>
<td>Polio</td>
<td>Ingestion of contaminated items</td>
<td>Mild flu-like symptoms, 95% asymptomatic</td>
<td>Paralysis involving respirations or swallowing and limb paralysis if &gt;60 days often permanent</td>
</tr>
<tr>
<td>Measles (rubeola)</td>
<td>Respiratory droplets</td>
<td>Fever, conjunctivitis, coryza, Koplik spot, splotchy rash on face then entire body by day 3</td>
<td>Leukopenia, bacterial super infections, otitis media, pneumonia, encephalitis, blindness, mortality 10% to 30%</td>
</tr>
<tr>
<td>Mumps</td>
<td>Respiratory droplets</td>
<td>Fever, swelling, tenderness of the sublingual, maxillary, or sublingual glands</td>
<td>Sensoneural hearing loss, pancreatitis, encephalitis, seizures, paralysis, hydrocephalus, 25% spontaneous abortion rate in first trimester of pregnancy</td>
</tr>
<tr>
<td>Rubella (German Measles)</td>
<td>Respiratory droplets</td>
<td>Fever, intense headache, nausea, vomiting, stiff neck, photophobia, petechial rash</td>
<td>With pregnancy, birth defects of deafness, heart defects, cataracts, mental retardation, liver and spleen damage</td>
</tr>
<tr>
<td>Varicella</td>
<td>Respiratory droplets, contact with lesions</td>
<td>Mild fever, maculopapular then rash that turns vesicular before scabbing over</td>
<td>Secondary bacterial infections from infected vesicles can result in disfiguring scars, necrotizing fasciitis, or septicemia</td>
</tr>
<tr>
<td>HPV</td>
<td>Sexually</td>
<td>Genital warts</td>
<td>Cervical cancer in women</td>
</tr>
</tbody>
</table>
Hepatitis B is transmitted by sexual contact and through infected blood and body fluids. Symptoms of the virus include anorexia, abdominal discomfort, nausea, vomiting, arthralgia, rash, and jaundice. Chronic hepatitis B virus occurs in 90% of infants born to infected mothers with 20% to 50% of children (age 1 to 5) infected from exposure due to close household contact. Between 15% and 25% of people with chronic hepatitis B will die prematurely from cirrhosis or hepatocellular carcinoma. U.S. hepatitis B disease rates have steadily declined with routine childhood immunization with current disease levels at 800,000 to 1.4 million.

Rotavirus is a virus that causes severe diarrhea, vomiting, fever, and dehydration in infants and young children, requiring hospitalization in 40% to 50% of cases. Rotavirus is spread by contaminated hands and objects often before children are symptomatic.

Respiratory diphtheria is an acute bacterial disease involving the tonsils, pharynx, larynx, and mucous membranes. Marked swelling of the neck may lead to tracheal airway obstruction. The diphtheria toxin can also cause myocarditis and heart block leading to heart failure. Devastating effects of diphtheria include chronic neuropa thyies and a 10% to 15% mortality.

Tetanus is a disease of the nervous system caused by the clostridium tetani bacteria. Early symptoms are lockjaw, stiffness in the neck and abdomen, and difficulty swallowing. Late symptoms include severe muscle spasms, generalized tonic seizures, and autonomic nervous system disorders. Subsequent complications include bone fractures and cardiac dysrhythmias with a 10% to 20% mortality.

Pertussis is an acute bacterial infection with the initial stage characterized by an irritating cough that becomes spastic within 2 weeks of infection. These coughing attacks expel large amounts of mucous and usually end with violent vomiting. The cough of final recovery stage may last for months. Complications from pertussis include pneumonia, atelectasis, seizures, encephalopathy, weight loss, hernia, and death usually resulting from complications of pneumonia.

Bacterial meningitis is caused by neisseria menigitidis, Streptococcus pneumoniae, and Hib. Hib causes a severe bacterial infection that occurs in children under age 5. This disease can cause epiglottitis, meningitis, pneumonia, and sepsis. Mortality is at 50% with many survivors suffering long-term complications including mental retardation, hearing loss, and loss of limb use. It is transmitted by respiratory droplets. The Hib vaccine prevents infection by Hib that causes the majority of cases of bacterial meningitis.

PCV pneumonia is spread by coughing, sneezing, or contact with respiratory secretions. This pneumonia causes high fever, dyspnea, bacteremia, and can lead to meningitis with mortality at 5% to 10%, affecting mostly infants and older adults. It is the most common cause of community-acquired pneumonia.

Poliomyelitis is a highly contagious viral infection with 95% of those affected remaining asymptomatic. Poliovirus infection occurs in the gastrointestinal system spreading to the lymph nodes, and eventually the central nervous system. The site of paralysis depends on the location of the nerve cell destruction in the brain stem or spinal cord. Typically, the legs are affected more often than the arms. Paralysis involving respirations or swallowing can be life threatening. Some improvement in paralysis may occur during convalescence but paralysis that persists beyond 60 days is likely to be permanent.

Measles or rubeola is an acute viral disease so contagious that those exposed who are not immune will most likely contract it. Measles begins with prodrome of fever and conjunctivitis, coryza (nasal drainage), and cough. Small white (Koplik) spots appear on an erythematous buccal mucosa followed by a characteristic red blotchy rash starting on the face on day 3 then spreading over the body for 4 to 7 days. Complications include leukopenia, bacterial super infections, otitis media, pneumonia, larygotracheobronchitis (croup), diarrhea, encephalitis, blindness with mortality at 10% to 30%. The disease is more severe in infants. Measles is usually spread by visitors to the United States.

Mumps is an acute viral disease characterized by fever, swelling and tenderness of the salivary, sublingual, or maxillary glands, and spread through respiratory droplets. With an incubation period of 14 to 25 days, mumps can cause sensorineural hearing loss, pancreatitis, and encephalitis leading to permanent seizures, paralysis, and hydrocephalus. Mumps occurring during the first trimester of pregnancy is associated with a 25% spontaneous abortion rate. Individuals born before 1957 are considered to be immune to mumps.

Rubella or German measles is an acute viral disease spread by respiratory droplets of coughing and sneezing that causes fever and rash. This disease is characterized by...
acutely onset of fever, intense headache, nausea, vomiting, stiff neck, and photophobia. A petechial rash may also be present. Severe birth defects include deafness, heart defects, cataracts, mental retardation, liver, and spleen damage if disease occurs during pregnancy.3

Varicella is an acute viral illness associated with a mild fever and a maculopapular rash, which turns vesicular before scabbing over. The varicella virus may cause a pneumonia and encephalitis sometimes leading to death. Secondary bacterial infection from infected vesicles can leave disfiguring scars or result in necrotizing fascitis or septicemia. Adolescents and adults are at greater risk for severe forms of this disease.3

HPV is the most common sexually transmitted infection in the United States. HPV causes genital warts in men and women and can lead to cervical cancer in women. By age 50, 80% of sexually active females have acquired the HPV infection.3 Seventy percent of HPV that cause cervical cancer is caused by strains that the new Gardasil vaccine offers protection against.3

### Vaccine safety

Vaccine safety is important and an ongoing surveillance is in place to monitor adverse reactions. The National Childhood Vaccine Injury Act was passed by Congress in 1986. Adverse events from immunizations are reported to the Vaccine Adverse Event Reporting System that was established in 1990 by the CDC and FDA. Adverse events are defined as health effects that occur after the immunization and may or may not be related to the immunization. Data are monitored continually to detect unknown adverse events or increases in adverse reactions.3 Vaccine Safety Data link, developed in 1990, is available to monitor vaccine safety; and includes comprehensive medical and immunization histories of 5.5 million people annually.

Immunizations are memorable events and any illness that occurs after vaccination is often attributed to the vaccine. Some incidents may be caused by the vaccine, but most are unrelated and coincidentally occur after the immunization. Knowledge of a true reaction to a vaccine and coincidence is necessary to maintain the trust and confidence of the public. Scientific research is ongoing to differentiate true adverse reactions from unrelated occurrences. Information that the public receives regarding immunizations is complex and may come from many different sources. Each practitioner has a duty to provide clear and accurate facts about vaccines to the public.3

### Common myths and realities

Parents present to clinicians with many myths regarding vaccines. NPs must be ready to counter the myths with reality. The most common myth is the association between vaccines and autism. In an online study 25% of parents agree that “some vaccines cause autism in healthy children.”19 There is no scientific evidence to support this and many studies have duplicated this finding.19 Autism is a developmental disorder that is evident in early childhood. Its symptoms include major impairment in socialization and communication, repetitive acts, restricted interests, and rigidity in behavior. To date, there is no known cause of autism. It is thought to be caused by brain dysfunction and genetic and environmental influences. Early signs of autism include failing to meet developmental milestones and poor eye contact and interaction with others. Most of these signs are not apparent until the child is 12 to 18 months old. Because the diagnosis of autism is often based on developmental milestones, the timing of vaccines often coincides with initial autism diagnosis.19 The prevalence of autism is 2-5/10,000 school-aged children with symptom onset before age 3.20 This condition is now diagnosed at a rate 25 times higher than in the 1970s. It remains unclear if this increase is due to better diagnosing or an actual increase in autism.20 Marcum,20 a clinical behaviorist and psychologist indicates that in past decades, people labeled as mentally retarded would now be called autistic. The number of children diagnosed as mentally retarded has significantly decreased proportionally.20 It has been hypothesized that thimerosal, a mercury containing preservative previously used in many vaccines, directly caused rise in autism. In California, a study was conducted on children who received vaccines containing high, low, and no exposure to the preservative thimerosal. In this retrospective study, autism rates actually increased as thimerosal was removed from the vaccines.21 Scahill and Bearss21 state that the increase in the number diagnosed with autism may be due to the Diagnostic and Statistical Manual of Mental Disorders 4th edition (DSM-IV) publishing a broader criteria for diagnosis of autism. Concern that autism is caused by vaccines sparked an overwhelming submission to the National Vaccine Injury Compensation Program After reviewing 5,000 pages of transcripts, 939 medical articles, 50 expert reports and testimony from 28 experts. The U.S. Court of Federal Claims ruled that there was no correlation with MMR vaccine or thimerosal preservative either alone or together that cause autism.19

Another misconception is that multiple vaccines overwhelm the infant’s immune system. Infants are exposed to numerous viruses and bacteria. Current vaccines contain less viral proteins than the initial smallpox vaccine. The smallpox vaccine contained 200 viral proteins and was the only recommended infant vaccination. The 11 current recommended childhood vaccines contain a total of 130 viral proteins.18
## Closing the immunization gap

### Vaccine myths

<table>
<thead>
<tr>
<th>Myth</th>
<th>Reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccines cause autism.</td>
<td>There is no scientific evidence to support this.(^{18})</td>
</tr>
<tr>
<td>Giving too many vaccines overwhelms the child’s immune system.</td>
<td>Millions of vaccines are given yearly with few adverse reactions. Numbers are even too low to calculate risk.(^{2})</td>
</tr>
<tr>
<td>Vaccines cause diabetes.</td>
<td>There is no link between vaccines and diabetes.(^ {19})</td>
</tr>
<tr>
<td>Vaccines are no longer necessary because the diseases are no longer a threat.</td>
<td>As a result of the safety and success of vaccines, diseases that killed and sickened millions are now rare. Low immunization rates may result in the reemergence of these diseases that are still prevalent in parts of the world.(^ {3})</td>
</tr>
<tr>
<td>Scientists are divided about the safety of vaccines.</td>
<td>The international medical community overwhelmingly supports that vaccines are safe, effective, and necessary.(^ {2})</td>
</tr>
<tr>
<td>Aluminum contained in vaccines is as toxic as mercury.</td>
<td>Aluminum salts are safe in small amounts. Antacids have 1,000 times as much aluminum as a vaccine does. Aluminum salts are used in vaccines to increase the immune response and extend the effectiveness of the vaccine.(^ {22})</td>
</tr>
<tr>
<td>Adults who as children were unvaccinated have no worry of vaccine preventable diseases if they remain healthy.</td>
<td>Unvaccinated adults remain susceptible to vaccine preventable diseases.(^ {16})</td>
</tr>
</tbody>
</table>


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The myth linking vaccines and diabetes was perpetuated by a single study that was not reproducible. There is no scientific link between diabetes and vaccinations.\(^ {18}\)

Aluminum levels contained in vaccines given to infants is another concern. Aluminum salts are safe in small amounts as one dose of an antacid has 1,000 times contained in a vaccine.\(^ {22}\) For aluminum to be toxic to humans there must be severe kidney impairment and aluminum must build up over years.\(^ {22}\)

The false assurance that unvaccinated adults are not vulnerable to childhood diseases is another misguided belief. Unvaccinated adults are susceptible to all communicable diseases that vaccines prevent. When these diseases are contracted by adults outcomes are often more detrimental.\(^ {18}\)

Some parents may believe that vaccines are no longer necessary because these diseases are not a threat with successful eradication efforts. World travel and decreasing immunization rates indicate these diseases could easily reemerge.\(^ {18}\) Parents may perceive division among scientists and the medical community regarding the safety of immunization. The international scientific and medical community support vaccines as safe and necessary.\(^ {3}\)

### Ethical issues

Immunizations protect the child who is immunized and help protect the community by providing herd immunity, decreasing the chances of disease outbreak. One of the growing concerns with the increasing numbers who elect not to immunize is caring for the children who cannot be immunized for medical reasons. Children who have allergic reactions to certain vaccines and those who are immunocompromised due to disease or chemotherapy are dependent on herd immunity for protection from the potentially devastating effects of these diseases.

### Conclusion

Due to inaccurate and misleading information parents may present with doubt and fear regarding vaccinations. Conflicting information about vaccines is abundant with anti-vaccination groups often organized, vocal, and easily accessible via the internet.\(^ {23}\) Government websites can be difficult to navigate and immunization schedules can be overwhelming to parents. Practitioners must stay current on vaccine studies so that they can communicate accurate information to their patients and ensure recommended vaccines are received. Taking the time at each patient encounter to determine immunization status will boost herd immunity.\(^ {8}\) Directing patients to accurate and informative resources such as [http://www.CDC.gov](http://www.cDC.gov) and [American Academy of Pediatrics website](http://www AAP.org) can help them make accurate, informed decisions. Closing the gap requires ongoing vigilance by providers reaching out to each patient. ©
REFERENCES


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DOI:10.1097/01.NPR.0000393970.21436.8b