OPERATION IMMUNIZATION
APhA ACADEMY OF STUDENT PHARMACISTS

2012 – 2013 Planning Guide
This guide will help your chapter plan, organize, and implement your APhA-ASP Operation Immunization projects and events.

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Special thanks to Safeway for their continued support of Operation Immunization.

Many of the Operation Immunization materials have been adapted from materials developed by the CDC and the APhA Immunization Certificate Training Program.

The following students played a significant role in the original development of the program materials for Operation Immunization in 1997:

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Dear Operation Immunization Coordinator:

The American Pharmacists Association Academy of Student Pharmacists (APhA-ASP) is excited to present Operation Immunization, a national patient care project designed to protect and improve public health through immunization delivery and education. The 2012-2013 Operation Immunization campaign has been made possible through an educational grant from Safeway, Inc.

Over the course of its 15-year history, the Operation Immunization campaign has provided student pharmacists with an opportunity to collaborate with local practitioners to provide immunizations and educate patients nationwide. Last year alone, student pharmacists worked alongside practitioners in their communities to educate over 27 million people.

By participating in Operation Immunization, your chapter can have a significant impact on the health of patients in your community. As part of the 2012-2013 campaign, we also encourage your chapter to advocate on behalf of the profession to educate the public about the benefits of pharmacy-based immunizations and the role pharmacists and student pharmacists can play in improving public health. While all 50 states allow pharmacists to immunize, student pharmacists are permitted to immunize under the supervision of a pharmacist in only 30 states. This may present an exciting opportunity for your chapter to become involved in the legislative process by educating your policymakers about how student pharmacists can support their efforts to reach the state’s immunization goals.

The enclosed resource guide contains information on effectively planning and implementing Operation Immunization at your chapter. We strongly encourage you to take advantage of this valuable resource and the opportunity to impact the health of patients in your community. At the conclusion of this guide, you will also find a reporting form to document your chapter’s activities for submission to APhA. Recognition will be given to all chapters that participate in the Operation Immunization campaign. Those chapters with the most innovative and successful projects will also receive regional and national awards at the 2014 APhA Annual Meeting & Exposition in Orlando, FL. Reports must be submitted no later than July 15, 2013 to be considered for an award.

Finally, I would like to express my gratitude to Safeway, Inc for its ongoing support of Operation Immunization and for recognizing student pharmacists for their role in improving public health. I challenge every APhA-ASP chapter to participate in this exciting program and work with pharmacists and other health care professionals in their area to make this year’s Operation Immunization campaign our most successful one to date!

Sincerely,

David R. Steeb, Student Pharmacist
2012-2013 APhA-ASP National President
Eshelman School of Pharmacy University of North Carolina at Chapel Hill
INTRODUCTION

Need for Immunizations

Immunizations are considered one of the greatest public health achievements in the United States during the last century. Immunization programs have nearly eliminated many of the vaccine-preventable diseases that were once common in the United States. In fact, routine vaccinations have prevented so much disease and averted so many deaths that people often forget about the devastation that can be caused by these diseases. Despite the current successes, it is only through ongoing immunization efforts that vaccine-preventable diseases will remain under control. If we become complacent in our vaccination efforts, these diseases may reappear and cause significant morbidity and mortality.

High accessibility lends pharmacists and student pharmacists to play a major role in ensuring higher immunization rates and decreasing the incidence of vaccine-preventable diseases. As of June 2011, over 100,000 pharmacists across 50 states have been certified to give immunizations. Approximately 30 states now allow student pharmacists to immunize as well. Student pharmacists in these states may also become involved through the legislative process by supporting their local pharmacy state board to lobby for changes in legislature and practice acts. By having pharmacists and student pharmacists administer immunizations or having the immunizations administered in a pharmacy, we hope to increase the public’s awareness of the important role both pharmacists and student pharmacists can play in public health.

Although pharmacists were involved in various roles in immunization in the late 1800’s and early 1900’s, this early involvement was short-lived due to many factors such as a daunting side-effect profile and collective vaccine-delivery programs. However, the last two dates of the 20th century saw a return of pharmacists to vaccine advocacy and delivery. In 2009 pharmacists were able to improve public health and help prevent the spread of the H1N1 virus. The most serious obstacles to the receipt of vaccines are the limited places and times of vaccine availability. Pharmacists rank among the most accessible healthcare providers giving them the opportunity to overcome shortfalls in immunization delivery. Immunization rates will climb as soon as patients are advised of their risks of preventable infection and are offered immunization; the rates will climb when you, a student pharmacist, participate in Operation Immunization.

Goals of Operation Immunization

Recognizing the need for education and increased opportunities to receive immunizations, the American Pharmacists Association Academy of Student Pharmacists (APhA-ASP) and the Student National Pharmaceutical Association (SNPhA) collaboratively developed Operation Immunization. This was the first service project of this magnitude in the history of APhA or SNPhA. This program is an immunization education campaign designed to increase the public’s knowledge of immunizations while raising the number of adults receiving immunizations. Participants include all of the APhA-ASP chapters with the help of trained practitioners and other healthcare professionals trained and certified to give immunizations.

While Operation Immunization is designed to benefit the public, your college campus is a great place to begin raising immunization rates and increasing awareness. Currently, the American College of Physicians recommends that annual influenza vaccine should be required for every healthcare worker with direct patient activities. These vaccines can effectively be given throughout the year and will prevent more than 50,000 deaths alone. The American Pharmacists Association (APhA) encourages
participants to continually increase community awareness of immunization information and advise patients on where they can obtain the proper immunizations year-round.

**Background on Operation Immunization**

Operation Immunization was launched as an official APhA-ASP National Patient Care project in 1997. Since that time, over 1 million individuals have an immunization through the Operation Immunization campaign. In 2011 alone:

- Number of schools participating in 2011 campaign \(\rightarrow 56\)
- Number of students participating in 2011 campaign \(\rightarrow 3,286\)
- Number of patients immunized in 2011 campaign \(\rightarrow 5,578\)
- Number of patients educated received Health & Wellness/Clinical Services \(\rightarrow 30,137\)
- Number of patients reached through public relations initiatives in 2011 campaign \(\rightarrow 27,949,574\)

**Operation Immunization Awards**

APhA-ASP recognizes each chapter that implements an Operation Immunization program in their community. In addition, one Chapter from each of the 8 APhA-ASP regions and 1 national winner are recognized during the APhA Annual Meeting & Exposition at the APhA-ASP Opening General Session, in Student Pharmacist magazine, and on the APhA website. For more information on the Operation Immunization reporting process, please refer to the “Reporting Guidelines” section of this planning guide.

**Highlights from the 2011 Award Recipients**

*National Winner: The University of Texas at Austin*

To increase their exposure to the community they collaborated with other pharmacy organizations for all their events and served more patients compared to previous years. They also provided a schedule detailing required vaccinations for children and adults tailored to their age, gender, and health conditions. Student pharmacists worked to educate the public on the important role pharmacists can play in increasing immunization rates and keeping patient records up-to-date.

*Region 1 Winner: University of Connecticut*

Partnering with the Residence Halls Association, the Resident Assistants on received a presentation with information about HPV, including myths, facts, statistics for men and women, and information on prophylaxis.

*Region 2 Winner: University of Maryland*

Student pharmacists provided a presentation with up-to-date information about available adult vaccinations for the parents of the Washington DC Taiwanese students. Chapter members also debunked some common vaccination myths and misconceptions and answered questions at the end of the presentation.

*Region 3 Winner: Mercer University*

Mercer APhA-ASP student pharmacists organized the Fourth Annual Multicultural Community Health Fair. Student pharmacists provided tetanus and pneumococcal immunizations to participants who met...
the criteria. All patients who received an immunization were asked to participate in a survey as part of an immunization grant from American Pharmacists Association Foundation.

Region 4 Winner: Ohio Northern University
To assist the Rice Foundation Clinic in Honduras, student made pamphlets with information about MMR, pentavalent (diphtheria, tetanus, pertussis, Hepatitis B, and Haemophilus influenza B), rotavirus, pneumonia, tuberculosis, hepatitis B and typhoid fever vaccines and translated into Spanish. The pamphlets were given to the health care providers at the clinic.

Region 5 Winner: University of Minnesota
Patient care project posters, including Operation Immunization, were set up at the ADA Walk to Fight Diabetes for participants to look at as they completed laps around the mall. This event allowed student pharmacists to target patients with diabetes and explain immunization recommendations for their specific population.

Region 6 Winner: University of Missouri-Kansas City
Pharmacy teams worked to provide emergency clinical services including immunizations, medication dispensing, and patient education. Over the first three days of establishment, 140 prescriptions were dispensed and 358 tetanus immunizations were administered through the efforts of the walking immunization clinic.

Region 7 Winner: Oregon State University
Held in conjunction with a weekly free meal program, “Cover the Uninsured Week” was co-sponsored by the medical, dental, nursing, physician assistants, and student pharmacists. Pharmacy provided immunizations, blood glucose screenings, medication reconciliation and OTC medication dispensing. Most patients were homeless or uninsured.

Region 8 Winner: The University of Arizona
In conjunction with Midwestern University- Glendale the two chapters provide health screenings and awareness booths on the state capitol lawn to open dialogue between state legislators and their staff about important issues facing pharmacy and how pharmacists can better serve the public with their support.
How to Use this Guide

This planning guide will help assist you with the implementation, management, and marketing of a successful immunizations campaign in your community. The material includes:

- Basic clinical practice information
- Step-by-step approach on how to run the campaign
- Suggested promotional material
- Additional resources
- Instructions for reporting

When it comes to your APhA-ASP Operation Immunization campaign, be creative, have fun, and most importantly, help your community get immunized.
Vaccine Successes and Shortfalls

Vaccines have had a tremendous impact on lowering the risk of many diseases. Routine childhood vaccines have eliminated so much disease and prevented so many deaths that many vaccine preventable diseases are now very rare. People forget about the diseases, but only through ongoing immunization efforts do we continue to control the diseases. If we become complacent in our vaccination efforts, these diseases may reappear, with their accompanying morbidity and mortality. Only once has a vaccine eradicated a microbe from the planet, allowing vaccination to be discontinued.\(^2,8\)

Because of vaccination, smallpox has been eradicated. The disease was a scourge for most of recorded history; about 30% of those who contracted it died. Survivors were often scarred or blinded by the variola virus. In 1796, Edward Jenner used cowpox scabs from a milkmaid to “vaccinate” a 7-year-old boy. Later, Jenner challenged the boy with intentional exposure to the smallpox virus. The boy stayed well, and smallpox vaccine gradually reduced the viral menace. Even so, 10 million people contracted smallpox worldwide in 1967, which resulted in 2 million deaths.

Thanks to a concerted global vaccination effort wiped out the virus completely. Our planet was declared free of smallpox by the World Health Organization in 1980. In addition to avoiding untold human misery, we avoid spending $1 billion each year because there is no longer any need to vaccinate our people against smallpox. \(^9\) Unfortunately, since the Fall of 2002, threats of rogue states and terrorist organizations utilizing smallpox virus as a bioterrorism agent have once again renewed efforts to vaccinate certain health care workers and military personnel. As of March 2009, the smallpox vaccine is only recommended for laboratorians who work with orthopox viruses, and public health and health care response team members who have no contraindications to the vaccine.

Routine childhood vaccines have achieved a remarkable success, better than 95% in each case, in controlling diseases like diphtheria, tetanus, pertussis, measles, mumps, rubella, poliomyelitis, and others. \(^4,10-14\) The key word, though, is “control.” If we stop vaccinating our children, these diseases will return. In addition, there have been several documented outbreaks of disease in un- or under-vaccinated people.

Further, we must not allow the success of childhood vaccines to lull us into a false sense of security. More than 35,000 people die, in an average year, of vaccine-preventable infections. Three diseases account for the vast majority of these unnecessary deaths: pneumococcal disease, influenza, and hepatitis B. \(^2-5,10-12,15\) Pharmacists can help prevent these needless deaths.

Vaccine Primer: Science and Practice

The basic scientific aspects of immunization and immunity are readily understood using a compare-and-contrast method. The following section describes the key features of applied immunology, using common examples.
Active vs. Passive Immunity

If someone is bitten by a rabid animal, two drugs are given: rabies immune globulin (RIG) and rabies vaccine. RIG promptly delivers someone else’s antibodies to the patient to help neutralize the rabies virus right away. These antibodies provide prompt protection, but that protection only persists for a few weeks. Giving antibodies in this way is called passive immunization.

Because rabies is a disease that incubates slowly, persistent immunity is needed to protect the patient. Rabies vaccine provides this protection. A five-dose series will protect a person for several years, ample time for post-exposure protection. But people take a couple of weeks to produce antibodies after being vaccinated. Causing people to make their own antibodies is called inducing active immunity.

In the case of a bitten patient, both RIG and rabies vaccine are needed for full protection. The first provides prompt but temporary help. The other gives delayed but persistent defense. A similar example is the distinction between hepatitis B immune globulin (HBIG) and hepatitis B vaccine.

Killed (Inactivated) vs. Live Attenuated Vaccines

The best known dichotomy among vaccines is probably the contrast between the Salk and Sabin poliovirus vaccines. Jonas Salk developed a killed viral vaccine (IPV) in the mid-1950s that is given by injection. A few years later, Albert Sabin devised an oral vaccine consisting of live but weakened polioviruses (OPV). In 1997, the national recommendation changed from a four-dose series of OPV to a mixed regimen of two IPV doses followed by two OPV doses. In 2000, it changed again to recommend IPV for all four doses.\(^{14}\)

This policy change was triggered by the small yet serious risk of contracting paralytic polio from the live vaccine.

<table>
<thead>
<tr>
<th>Major Causes of Vaccine-Preventable Infection, United States</th>
<th>2, 4, 10–12, 15</th>
<th>Infections per year</th>
<th>Deaths per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumococcal Disease</td>
<td>~555,000</td>
<td>40,000</td>
<td></td>
</tr>
<tr>
<td>Influenza</td>
<td>25 to 50 million</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>150,000 to 200,000</td>
<td>5,000</td>
<td></td>
</tr>
</tbody>
</table>

The most recent comparison between live and inactivated vaccines occurs between inactivated influenza vaccine and live, attenuated cold-adapted influenza virus vaccine. The inactivated vaccine is administered intramuscularly (IM), whereas the live, attenuated influenza vaccine is administered intranasally, replicating in the nasal passageway and providing both local and systemic immunity. This contrast in influenza vaccine is important because ACIP has traditionally advised health care providers to focus annual influenza vaccination efforts on high-risk populations. Because the live, attenuated influenza vaccine has the potential (although very slight) to cause a mild form of the illness, the Centers for Disease Control and Prevention (CDC) has approved the use of this vaccine only in otherwise healthy individuals aged 2 to 49 years.
Live attenuated vaccines must replicate in the body to produce and immune response. People with immunodeficiency should not receive live vaccines because of the risk of uncontrolled antigen replication. Killed vaccines do not replicate. Live vaccines also tend to have more stringent storage requirements. Among veterinary vaccines, both killed and live, attenuated rabies vaccines are available. Conventional wisdom has it that live vaccines induce more persistent immunity, although there are exceptions to this rule, and killed vaccines often require booster doses.

**Toxoids vs. Vaccines, Whole or Partial**

Toxoids are a specific kind of vaccine. Toxoids are formed by inactivating a biological toxin, most often by mixing it with formaldehyde. The product known as DTP consists of two toxoids and a traditional vaccine: diphtheria and tetanus toxoids and pertussis vaccine. The normally poisonous toxins are rendered harmless but are still able to evoke a protective antibody response after injection. Because toxoids are a specific kind of vaccine, it is proper to simply refer to DTP as a vaccine. The pertussis component of DTP illustrates the case where two different forms of vaccine are available. The traditional DTP vaccine (now called DTwP) contains whole-cell pertussis vaccine: whole pertussis bacteria killed with formaldehyde. Beginning in December 1991, the Food and Drug Administration (FDA) licensed DTP vaccines containing acellular pertussis components, in combinations known as DTaP. Acellular pertussis vaccines contain only certain fragments of pertussis bacteria. The presence of fewer pertussis proteins is believed to give DTaP vaccines their advantage of causing fewer bothersome side effects. Because of this DTwP is no longer available in the United States.

**Polysaccharides vs. Proteins**

The active ingredients of most vaccines are the proteins found in bacteria and viruses. But a few vaccines work by inducing antibodies to polysaccharides, usually those found in the external capsules of bacteria. For example, influenza vaccines rely on protein constituents, whereas pneumococcal vaccine consists of capsular polysaccharides. Some meningococcal vaccines and *Haemophilus influenzae* type b (Hib) vaccines also consist of polysaccharide antigens.

Unfortunately, polysaccharide vaccines offer little or no protection to children under 2 years old. Protein-based vaccines, on the other hand, work well in infants. This situation is well illustrated in the history of *Haemophilus influenzae* vaccines.

The initial Hib vaccines licensed in the United States contained polysaccharides only and were limited to immunization of children over 2 years of age. When scientists later developed methods of linking, or conjugating, these polysaccharides to protein “carriers,” immunization of children as young as 2 months of age became effective. This approach also was utilized in the 13-valent conjugated pneumococcal vaccine (Prevnar 13-Pfizer). Two meningococcal conjugated vaccines, (Menactra—a sanofi) and (Mencev – Novartis) were approved since 2005 and offer better, longer-lasting protection.

**Primary vs. Booster Responses**
Some vaccines that are protective shortly after an initial dose include influenza, pneumococcal, and yellow fever. Others require several doses to achieve protective levels of antibodies. Several doses are more likely to be required if the recipient is an infant (e.g., DTaP, IPV, Hib), if protection is needed urgently (e.g., rabies), or if the person has not had much natural exposure to the microbe (e.g., influenza and PCV for children). For vaccines that require a series (i.e., HepA, HepB, DTaP, etc.), all of the doses in the series are considered primary doses required to provide complete protection.

Booster doses, required when biological antibody titers wane over time, are needed intermittently, and vary with the specific vaccine. Adult booster doses of tetanus-diphtheria toxoids (Td), or tetanus-diphtheria and acellular pertussis (Tdap) are given every 10 years, and once, respectively, after the basic five-dose DTaP series or the three-dose primary series of Td for adults. Pneumococcal vaccine is generally needed only once among adults, unless they are at unusually high risk. Annual immunization against influenza is needed because of changing antigenic characteristics of circulating viruses; in addition, anti-influenza antibodies often persist less than 1 year. Booster doses of hepatitis B vaccine are not routinely recommended at this time except for dialysis patients who have lost anti-HBs antibodies and people who are immunosuppressed.

In some cases, additional doses are given to increase the proportion of recipients who develop immunity, not to increase the antibody concentrations in recipients. For example, multiple doses of poliovirus vaccine are given to increase the likelihood of seroconversion and protection. The 1989 recommendation of giving a second dose of measles-mumps-rubella (MMR) vaccine to those born since 1957 is intended to increase the number of vaccinees who respond to the vaccine. A second dose of varicella vaccine is needed to achieve the high response rate (>99%) required for this very infectious disease.

Cellular vs. Humoral Immunity

Many people think that immunity is synonymous with the protection provided by antibodies, but the immune system is far more sophisticated than that. One of the standard approaches is to distinguish between two general mechanisms of immune response: humoral immunity and cell-mediated immunity. These two types usually can be distinguished by their speed.

Humoral or antibody responses are generally considered “immediate” (i.e., within minutes), whereas cellular immune responses are considered “delayed” (i.e., within 24 to 72 hours).

Humoral immunity involves antibodies. The word “humoral” refers to things related to the “humors” of the body, things smaller than cells. Although humanity has known of the existence of cells for hundreds of years, people did not discover that antibodies could be found among the gamma globulin proteins of serum until 1938. It is common to perform blood tests to measure the concentration of antirubella antibodies or antihepatitis B antibodies someone has, but these tests do not begin to measure the extent of someone’s cellular immunity. Cellular immunity induced by vaccination is the method by which one can
be protected from hepatitis B even when measurable antihepatitis B antibodies cannot be detected in the bloodstream.

Cell-mediated immunity involves macrophages, other antigen-presenting cells, and T-lymphocytes. Even after antibody levels drop over time, the cell-mediated immune response triggers another very rapid antibody elevation. This is true even when antibody levels drop to below measurable levels, as is often the case with hepatitis B vaccine. Subsequent exposure to hepatitis B virus or to another dose of hepatitis B vaccine will cause a very rapid antibody rise. This would occur faster than the incubation period for the natural disease, thus providing protection against that disease.

While not an immunization, the response to tuberculin skin tests primarily involves cell-mediated immunity cells. Immunogens in the purified protein derivative (PPD) of tuberculin interact with T-lymphocytes to produce the characteristic Koch-type (delayed-type) hypersensitivity response.

Tetanus toxoid can be used to take advantage of both humoral and cellular immunity. Tetanus toxoid is primarily used, of course, to induce tetanus antitoxin antibodies when it is used as a vaccine. Conversely, allergists may inject dilute concentrations of tetanus toxoid intradermally to see if they can evoke a delayed hypersensitivity response, when they want to assess a patient’s state of anergy.

**Vaccines vs. Allergen Extracts**

Vaccines induce active production of IgG antibodies to protect against infection. Allergen extracts, on the other hand, are used to treat hay fever, allergic asthma, and related conditions. These diseases are believed to be mediated by IgE antibodies, which induce mast cells to release histamine.

Allergen extracts are complex, variable mixtures of proteins, carbohydrates, and other substances. They are produced by extracting plant pollens, animal pelts, or other allergen sources with an extracting fluid, in a process similar to coffee percolation. Allergen extracts exhibit substantial variability in potency from lot to lot.

To learn the intricacies of dose adjustment, spend some time with an allergist. Additional information about allergen extracts and *Hymenoptera* venoms is printed elsewhere. See detailed references for specific information.

**Review of Diseases and Microbes**

To prepare pharmacists for vaccine delivery, we will review the epidemiology of the viruses and bacteria corresponding to the most commonly used vaccines. This section considers each microbe in turn, reviewing disease characteristics and complications, vaccine indications and contraindications, dosage, and important adverse vaccine effects.

**Influenza**

Influenza is a disease caused by several types of highly contagious orthomyxoviruses. The influenza pandemic of 1918–19 killed more than 21 million people around the globe, 1% of the planet’s
population. A pandemic is a global epidemic. This toll was more than the death toll from World War I and World War II combined. Lesser pandemics occurred in 1932, 1957, and 1968. The most recent pandemic occurred in 2009 (H1N1).

Influenza type A is a moderate or severe illness affecting people of all ages. Influenza type B, on the other hand, is typically milder, primarily affecting children. Both types are characterized by abrupt onset of fever, myalgia, sore throat, and nonproductive cough. Pneumonia is the most common complication of infection with influenza. Other complications may include myocarditis or Reye’s syndrome. Influenza can worsen preexisting chronic pulmonary diseases. Death results in 1 of each 1,000 to 2,000 people who develop influenza. Increased mortality typically accompanies an influenza epidemic, with mortality increases seen from exacerbations of pre-existing cardiopulmonary and other chronic diseases. Post-exposure prophylaxis and therapeutic treatments of influenza must be initiated within 48 hours of onset of symptoms to reduce the morbidity and mortality of the disease.

If exposed to the influenza virus, a person’s risk of influenza infection ranges from 5% to 33%.3, 17, 33, 34 An average of 114,000 hospitalizations are related to influenza each year, with greater than 50% of these being among persons younger than 65 years. The rate of hospitalization increases in years when influenza A (H3N2) is predominant. On average, there are over 20,000 influenza-associated deaths annually from respiratory or circulatory causes. Death rates during epidemics may be greater. More than 90% of these deaths were among people age 65 and older. Many more deaths precipitated by influenza are probably attributed to other causes. Each influenza epidemic costs more than $12 billion in direct and indirect medical costs.

CDC estimates that pandemic H1N1 influenza virus caused more than 60 million Americans to become ill, and led to more than 270,000 hospitalizations and 12,500 deaths. Ninety percent of hospitalizations and deaths occurred in persons younger than 65 years of age. With typical seasonal influenza approximately 90% of deaths occur in persons older than 65 years.

Influenza viruses change surface antigens to evade the immune system. Type A viruses have two major antigens: hemagglutinin (H) and neuraminidase (N). Two major types of antigenic change are known: antigenic drift and antigenic shift. Antigenic drift occurs continuously. It results in frequent minor changes in the antigenic structure of the virus. Drift can be associated with epidemics if the difference from previous antigenic versions is big enough. Antigenic shift involves major changes of one or both major antigens, creating a new subtype. Because of the major differences between the new virus and the previously circulating strains, a pandemic of disease may occur after antigenic shifts.

The frequent drifts in influenza surface antigens are what necessitate the annual changes in the influenza vaccine formula. Influenza vaccines in recent years have contained three vaccine components: type A/H1N1, type A/H3N2, and type B antigens. Starting in the 2013-14 influenza season, a vaccine containing a fourth component, a second type B antigen (FluMist Quadrivalent – MedImmune).

Influenza disease most commonly peaks in the contiguous 48 states from December to March each winter. Influenza vaccination programs should optimally be carried out prior to the onset of influenza activity in the community. Influenza vaccine should be offered up to and even after influenza virus
activity is documented in a community to those at risk missed during mass influenza immunization programs.\textsuperscript{17}

In years past, two kinds of influenza vaccine were available, both of which consist of inactivated viruses. These vaccines contain either whole viruses or split-viral particles. Both types of vaccine had comparable efficacy, but the split-virus influenza vaccine causes fewer febrile reactions in children younger than 12 years old and is recommended in that group. As a result of this difference in adverse effect profile, manufacturers have discontinued production of whole virus vaccine and currently produce only split-virus vaccine.

Efficacy of influenza vaccine varies by the degree of similarity between the vaccine strain and circulating viruses. Influenza strains are chosen by influenza experts early each year for the coming autumn’s vaccine formula, based on expectations for the dominant influenza strain in the coming season. Efficacy also varies with the recipient’s immune competence, falling with advancing age or underlying illness. Vaccination reduces the risk of illness by about 90% among healthy young adults, but by only 30% to 40% among frail elderly patients. Even so, older vaccinees are two to four times less likely to be hospitalized, develop pneumonia, or die if they do contract influenza. The vaccine protects for less than a year. Protective antibody wanes over 6 to 12 months after immunization. Therefore, annual vaccination is recommended.

The influenza vaccine is recommended for all persons without a contraindication aged 6 months and older. Children 6 months to 8 years require 2 doses of the vaccine during the first season separated by at least 4 weeks. The intramuscular dose for children under 3 years is 0.25mL and the dose for children and adults 3 years and older is 0.5mL. There are multiple brands of the trivalent inactivated influenza vaccine (TIV). Most of the vaccines differ on their FDA-approved age group. The table below outlines the available influenza vaccines.

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Trade name</th>
<th>Manufacturer</th>
<th>Presentation</th>
<th>Mercury content (µg Hg/0.5 mL dose)</th>
<th>Ovalbumin content (µg /0.5mL dose)</th>
<th>Age group</th>
<th>No. of doses</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIV</td>
<td>Fluzone</td>
<td>Sanofi Pasteur</td>
<td>0.25 mL prefilled syringe</td>
<td>0.0</td>
<td>---†</td>
<td>6–35 mos</td>
<td>1 or 2§</td>
<td>IM¶</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.5 mL prefilled syringe</td>
<td>0.0</td>
<td>---†</td>
<td>≥36 mos</td>
<td>1 or 2§</td>
<td>IM¶</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>0.5 mL vial</td>
<td>0.0</td>
<td>---†</td>
<td>≥36 mos</td>
<td>1 or 2§</td>
<td>IM¶</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5.0 mL multidose vial</td>
<td>25.0</td>
<td>---†</td>
<td>≥6 mos</td>
<td>1 or 2§</td>
<td>IM¶</td>
</tr>
<tr>
<td>TIV</td>
<td>Fluvirin</td>
<td>Novartis Vaccines</td>
<td>0.5 mL prefilled syringe</td>
<td>≤1</td>
<td>≤1</td>
<td>≥4 yrs</td>
<td>1 or 2§</td>
<td>IM¶</td>
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<td>5.0 mL multidose vial</td>
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<tr>
<td>TIV</td>
<td>Fluarix</td>
<td>GlaxoSmithKline</td>
<td>0.5 mL prefilled syringe</td>
<td>0</td>
<td>≤0.05</td>
<td>≥3 yrs</td>
<td>1 or 2§</td>
<td>IM¶</td>
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<td></td>
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<td></td>
<td>5.0 mL multidose vial</td>
<td>25.0</td>
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<tr>
<td>TIV</td>
<td>FluLaval</td>
<td>ID Biomedical</td>
<td>0.5 mL prefilled syringe</td>
<td>0.0</td>
<td>≤1</td>
<td>≥9 yrs**</td>
<td>1</td>
<td>IM¶</td>
</tr>
<tr>
<td></td>
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<td>Corporation of</td>
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<td></td>
<td>Quebec (distributed by GlaxoSmithKline)</td>
<td>5.0 mL multidose vial</td>
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<tr>
<td>TIV</td>
<td>Afluria</td>
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<td>5.0 mL multidose vial</td>
<td>24.5</td>
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<tr>
<td>TIV High-</td>
<td>Fluzone</td>
<td>Sanofi Pasteur</td>
<td>0.5 mL prefilled syringe</td>
<td>0.0</td>
<td></td>
<td>≥65 yrs</td>
<td>1</td>
<td>IM¶</td>
</tr>
<tr>
<td>Dose††</td>
<td>High-Dose</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIV</td>
<td>Fluzone</td>
<td>Sanofi Pasteur</td>
<td>0.1 mL prefilled</td>
<td>0.0</td>
<td></td>
<td>18–64 yrs</td>
<td>1</td>
<td>ID</td>
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<tr>
<td>Intradermal</td>
<td>Intradermal</td>
<td>microinjection</td>
<td>system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAIV</td>
<td>FluMist§§</td>
<td>MedImmune</td>
<td>0.2 mL prefilled</td>
<td>0.0</td>
<td></td>
<td>2–49 yrs***</td>
<td>1 or 2§</td>
<td>IN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>intranasal sprayer</td>
<td>intranasal sprayer</td>
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<td></td>
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</tr>
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</table>

**Abbreviations:** TIV = trivalent inactivated vaccine; LAIV = live attenuated influenza vaccine; IM = intramuscular; ID = intradermal; IN = intranasal.

* Vaccination providers should check Food and Drug Administration–approved prescribing information for 2011–12 influenza vaccines for the most updated information.

† Information not included in package insert but is available upon request from the manufacturer, Sanofi Pasteur, by telephone, 1-800-822-2463, or e-mail, MIS.Emails@sanofipasteur.com.

§ Children aged 6 months through 8 years who did not receive seasonal influenza vaccine during the 2010–11 influenza season should receive 2 doses at least 4 weeks apart for the 2011–12 season. Those children aged 6 months through 8 years who received ≥1 dose of the 2010–11 seasonal vaccine require 1 dose for the 2011–12 season.

¶ For adults and older children, the recommended site of vaccination is the deltoid muscle. The preferred site for infants and young children is the anterolateral aspect of the thigh.

** Age indication per package insert is ≥25 years; however, the Advisory Committee on Immunization Practices recommends
Afluria not be used in children aged 6 months through 8 years because of increased reports of febrile reactions in this age group. If no other age-appropriate, licensed inactivated seasonal influenza vaccine is available for a child aged 5–8 years who has a medical condition that increases the child’s risk for influenza complications, Afluria can be used; however, providers should discuss with the parents or caregivers the benefits and risks of influenza vaccination with Afluria before administering this vaccine. Afluria may be used in persons aged ≥9 years.

†† TIV high-dose: A 0.5-mL dose contains 60 µg each of A/California/7/2009 (H1N1)-like, A/Perth/16/2009 (H3N2)-like, and B/Brisbane/60/2008-like antigens.

§§ FluMist is shipped refrigerated and stored in the refrigerator at 35°F–46°F (2°C–8°C) after arrival in the vaccination clinic. The dose is 0.2 mL divided equally between each nostril. Health-care providers should consult the medical record, when available, to identify children aged 2–4 years with asthma or recurrent wheezing that might indicate asthma. In addition, to identify children who might be at greater risk for asthma and possibly at increased risk for wheezing after receiving LAIV, parents or caregivers of children aged 2–4 years should be asked: “In the past 12 months, has a health-care provider ever told you that your child had wheezing or asthma?” Children whose parents or caregivers answer “yes” to this question and children who have asthma or who had a wheezing episode noted in the medical record within the past 12 months should not receive FluMist.

¶¶ Insufficient data available for use of LAIV in egg-allergic persons.

*** FluMist is indicated for healthy, nonpregnant persons aged 2–49 years.

The issue of thimerosal in vaccines has been largely overstated in the media. Thimerosal is a mercury-containing compound that has been used as a preservative in vaccines since the 1930s. In multidose vials of influenza vaccine, thimerosal helps to prevent bacterial contamination. While there has not been any scientific evidence to show short- or long-term harm from exposure to thimerosal, federal agencies have recommended that manufacturers strive to reduce or remove the preservative from all products, and particularly those used in infants. Therefore, based upon this recommendation, the thimerosal-free influenza vaccines referenced above should preferentially be used in children. However, if thimerosal-free influenza vaccine is unavailable, it is acceptable to immunize children with thimerosal-containing vaccine.

Significant contraindications include a previous severe allergic reaction to the vaccine. Defer immunization until after a moderate or severe acute illness improves. For adverse effects, expect local reactions at the injection site in fewer than 30% of recipients, with fever or myalgias in fewer than 1%. These effects result mainly if the person has had no prior exposure to antigens in the vaccine. Neurologic reactions are very rare to nonexistent after influenza immunization. Guillain-Barré syndrome (GBS) is rarely associated with influenza vaccine, but this risk is far overshadowed by the number of deaths due to influenza infection. Prior GBS is not a contraindication to vaccination.

Since the influenza virus is grown in hen eggs as part of the manufacturing process, people with allergic reactions to eggs should be cautioned when receiving the influenza vaccine. Recent evidence suggests that non-life threatening allergic reactions are of little concern and the risk of reaction is less than the benefit of preventing influenza. The ACIP issued the following decision tree when dealing with a patient with an egg allergy.
Despite the popular myth, influenza vaccine cannot cause influenza. The viruses are killed by formaldehyde during manufacture. Because of their short incubation time, 2 to 5 days, coincidental infections with influenza or other viruses near the time of vaccination may be misinterpreted by a vaccinee to have been caused by the vaccine. It is possible for vaccinees to develop breakthrough influenza despite immunization, but other viral infections are more frequent explanations.

Several reports suggest that HIV viral concentrations increase in HIV-infected people who receive influenza vaccine. These increases are transient and do not appear to adversely affect HIV disease. HIV-infected people need disease protection offered by many vaccines, including influenza vaccine. As discussed above, influenza viruses change surface antigens to evade the immune system. When the difference in surface antigens is big enough, major far-reaching epidemics (called pandemics) can occur. Moderate-sized influenza pandemics occurred in 1947–48, 1957–58, and 1968–69.

The novel influenza A (H1N1), known also as the swine flu, was first identified in April 2009 and was declared a pandemic in June 2009. It was antigenically distinct from other H1N1 viruses in circulation since 1977. The median age of confirmed cases was 20 years with children under 4 years having the
highest incidence of hospitalization. What made the 2009 H1N1 pandemic unique was its lower morbidity rates in people over 65 years. Whereas about 90% of seasonal influenza related deaths occurred in persons 65 years and older, only 8% of the H1N1 deaths occurred in the same age range.

During the 1918–1919 pandemic, people died in such numbers that there were shortages of wood to build coffins. Schools, churches, and theaters closed to reduce spread of the infections. Trains stopped running because there were not enough trained personnel. Food distribution failed in many communities. To put this into perspective, cardiovascular disease has been the leading cause of death in the United States every year to date since 1900, except for 1918 when influenza took the top spot. If a pandemic like this happened in our day, malls and interstate highways would close, and airlines would stop flying.

Because influenza viruses keep changing their surface antigens, could one of these changes precipitate another devastating pandemic like the one of 1918–19? Experts assume the answer is “yes” and are developing a plan to produce a vaccine to prevent the grim toll of death and devastation of 1918–19.

In 1918, emergency hospitals were built in auditoriums and under tents, but there was little science could do at that time to stop the outbreaks. This was the therapeutic age of quinine, strychnine, and digitalis. Today, if public health experts called for the entire population of 270 million Americans to be vaccinated against some new strain of influenza, the nation’s current health care structure would be overwhelmed. The nation’s 52,000 pharmacies offer major advantages in emergency vaccine delivery: health professionals skilled at vaccine storage and patient education, proximity to individual neighborhoods, ample parking lots, and computerized communication capabilities.

If or when the next influenza pandemic strikes America, pharmacists may well be called on to help immunize the nation.

Pharmacists can act as community leaders to help maintain order and prevent the chaos and panic seen in 1918–19. Without much exaggeration, the fate of your family and your neighbors might depend on your willingness to help. For more information, read Alfred W. Crosby’s book, America’s Forgotten Pandemic: The Influenza of 1918 (New York: Cambridge University Press, 1989).

In 2003 the FDA approved an intranasal live attenuated cold-adapted influenza vaccine (LAIV). The vaccine produces an immune response similar to that produced by natural infection, providing an antigenic response to the wild influenza strain. LAIV proliferates in the cooler upper respiratory system, where it stimulates mucosal antibodies. The vaccine contains millions of the tissue culture infective dose of the three attenuated strains in the influenza vaccine for injections. Studies have indicated that the vaccine is safe and efficacious in up to 95% of the population and effective in preventing influenza’s complications.34,35 Intranasal influenza vaccine is indicated for use in otherwise healthy individuals between the ages of 2 to 49 years old. It is not indicated in high risk populations or patients outside of this age range at this time. The vaccine should be stored at 35-46°F. The total dose is 0.2 mL, administered via nasal apparatus in one 0.1 mL premeasured dose to each nostril.

Because the intranasal influenza vaccine is a live vaccine, it is possible for this vaccine to cause influenza. However, pre-marketing trials showed that the incidence of vaccine virus influenza was very low and the severity of vaccine virus infection was significantly less than those cause by wild influenza virus.36,37
**Pneumococcal Disease**

Pneumococcal disease is the term for a group of infections caused by *Streptococcus pneumoniae*, a gram-positive coccobacillus bacterium. There are 90 known serotypes of *S. pneumoniae*. The bacterium was first isolated by Louis Pasteur in 1881 from the saliva of a patient with rabies. An association between the bacteria and pneumonia was made by Friedlander and Talamon in 1883, but it wasn’t until the advent of the Gram stain in 1884 that physicians were able to differentiate pneumococcal pneumonia from other types.

More than 500,000 people contract pneumococcal pneumonia in the United States each year leading to 175,000 hospitalizations. The death rate for this infection is 5% to 7%, despite appropriate antibiotic therapy. Pneumococci account for about one-third of community-acquired pneumonias and half of all hospital-acquired pneumonias. Pneumococcal pneumonia is a common complication of influenza and measles. Pneumococcal bacteremia affects 50,000 Americans, with a 20% death rate (up to 60% among the elderly) despite antibiotic therapy. The third type of pneumococcal disease is pneumococcal meningitis, causing 3,000 to 6,000 infections per year. Infection leads to death for some 30% of these people (up to 80% among the elderly), despite antibiotics. Signs and symptoms of pneumococcal meningitis are very similar to other bacterial causes of meningitis and may include headache, lethargy, irritability, cranial nerve signs, seizures, vomiting, and coma. *Streptococcus pneumoniae* accounts for almost 20% of all bacterial meningitis and has been the leading cause of childhood meningitis. Neurologic sequelae are common. Death rates for all three forms of pneumococcal disease are much higher among the elderly than among others. In addition to these serious forms of the illness, a noninvasive form of pneumococcal illness is otitis media, occurring in children younger than 5 years of age at the rate of approximately 5 million cases per year. While the burden of otitis media is not significant in terms of mortality data, it is a significant cause of lost time from work for parents and costs related to physician’s visits and antibiotic therapies.

Polysaccharide capsules confer virulence and provide the antigen that induces immunity. The antibodies produced by the immune system to capsular polysaccharides are type-specific, although there may be some cross-reactivity with related types. Penicillin is the drug of choice for treatment of pneumococcal disease; erythromycin for pneumonia and chloramphenicol for meningitis are acceptable in penicillin-allergic patients. However, drug-resistant strains are becoming more common, accounting for up to 40% of isolates in some areas, requiring use of newer, more broad-spectrum agents. Pneumococcal disease is the leading cause of vaccine-preventable death in this country, causing more than 40,000 deaths each year. 2-5, 18, 31

The 10 most common serotypes of *S. pneumoniae* cause about 62% of invasive disease worldwide, and 23 serotypes account for 85% to 90% of invasive disease. It is important to note that seven serotypes isolated from the blood or cerebrospinal fluid of children younger than 6 years of age account for 80% of infections in this group. These seven serotypes only account for about 50% of infections in older adults and children, which has an important impact on vaccine selection in specific patient populations as will be discussed later in this section.

Most pneumococci are probably transmitted from asymptomatic carriers by respiratory droplets. There is a high rate of asymptomatic carriage in healthy children and adults. The pneumococcus colonizes the
nasopharynx of 5% to 10% of healthy adults. Pneumococcal pneumonia has a short incubation period of only 1 to 3 days and typically has an abrupt onset with symptoms of fever, shaking chill, productive cough, pleuritic chest pain, malaise, weakness, and dyspnea, tachypnea, and hypoxia. Infrequently, nausea, vomiting, and headaches also may occur. Unlike influenza, the pneumococcal disease threat exists year round, although it is most common in winter and early spring. Annually, pneumococcal disease costs the U.S. health care system an estimated $1.5 billion.

Pneumococcal polysaccharide vaccine (23-valent) reduces the risk of invasive disease by 60% to 70%. Vaccine efficacy declines with advancing age and underlying illness but still provides substantial protection. Each 0.5-mL dose contains 25 mcg each of 23 purified capsular polysaccharide types. These 23 types account for 88% of bacteremic pneumococcal disease and cross react with types causing another 8%. Because it is a polysaccharide vaccine, it is not effective in children younger than 2 years old.

The first pneumococcal vaccine, containing six pneumococcal types, was produced by E. R. Squibb & Sons in 1947. Because physicians preferred another new drug, penicillin, vaccine sales were insufficient to justify marketing it. Squibb withdrew its pneumococcal vaccine in 1954. Improved 14-valent vaccines were licensed in 1977, with the current 23-valent vaccine following in 1983.

Vaccinate people over 2 years of age at high risk for pneumococcal infection with the 23-valent vaccine. Everyone aged 65 and older (even if healthy) and anyone aged 2 years and older with certain chronic illnesses should receive the 23-valent pneumococcal polysaccharide vaccine (PPSV23). In addition, smokers or people with asthma aged 19-64 years should receive the PPSV23.

The chronic illnesses for receiving PPSV23 include:

- Cardiovascular disease (e.g., congestive heart failure, heart valve problems, septal defect, post‐myocardial infarction, angina, ischemic heart disease, atherosclerosis, aneurysms, dysrhythmias, stroke, rheumatic heart disease, other heart diseases)
- Pulmonary disease (e.g., emphysema, chronic obstructive pulmonary disease, cystic fibrosis, chronic bronchitis, related conditions)
- Metabolic disease (e.g., diabetes mellitus)
- Immunosuppression (e.g., Hodgkin’s disease, lymphoma, multiple myeloma, nephrotic syndrome, asplenia, infection with the human immunodeficiency virus [HIV], organ transplant, drug‐induced immunosuppression)
- Other: cerebrospinal fluid leaks, renal dysfunction, hemoglobinopathies (e.g., sickle cell), myasthenia gravis, cochlear implants

The dose of 23-valent vaccine is 0.5 mL SC or IM (preferred by many clinicians as less painful). Typically, a single lifetime administration of the vaccine is sufficient for most patients. Revaccinate recipients of the 23-valent vaccine if immunized more than 5 years ago, if they are at highest risk of fatal disease (e.g., asplenia), or if there is rapid decline in antibody levels (e.g., nephrotic syndrome, renal failure, transplant recipients). This category includes most people with an immunosuppressive disorder or on immunosuppressive therapy. Give a second dose of this vaccine to people aged 65 and older if they were younger than 65 when they received their first dose and if that dose was more than 5 years ago. At this time ACIP recommends only one booster dose, for a maximum of two doses of pneumococcal polysaccharide vaccine, in a patient’s lifetime.
In February 2000, FDA licensed a 7-valent pneumococcal conjugate vaccine (Prevnar, PCV7). \(^\text{31}\) In February 2010, the FDA licensed a 13-valent version of the vaccine (PCV13). In the United States, there were about 16,000 cases of pneumococcal bacteremia and 1,400 cases of pneumococcal meningitis each year among children under age 5. The PCV13 targets the thirteen serotypes (strains) of pneumococcus that cause about 61% of all pneumococcal invasive disease in children less than 5 years of age in the United States. These serotypes are also among the most resistant to antibiotics traditionally used to treat pneumococcal infections. The PCV13 replaced the PCV7 for routine use in children. The most frequently reported adverse events included injection site reactions, fever (> 38°C), irritability, drowsiness, restless sleep, and decreased appetite.

The only significant contraindication to pneumococcal immunization is a previous severe allergic reaction to the vaccine.

Defer immunization until after a moderate or severe acute illness improves. For adverse effects, expect mild pain and redness at the injection site in 30% to 50% of recipients, with fever or myalgias in fewer than 1%. Pneumococcal and influenza vaccines can be given simultaneously at different injection sites.

**Tetanus**

Tetanus is a toxin-mediated neuromuscular disease caused by *Clostridium tetani*, an anaerobic gram-positive bacillus. Tetanus spores are ubiquitous, found in soil, dust, and feces. Tetanus toxins are produced when the spores germinate and the microbe replicates. The toxin binds in the CNS and blocks neurotransmitters, preventing muscle relaxation and causing tetany. The disease presents with descending symptoms: trismus (lockjaw), difficulty swallowing, and muscle rigidity and spasms. These spasms can persist 3 to 4 weeks. About 30% of people with tetanus die. The fatality rate is higher among the elderly. Tetanus can be complicated by respiratory insufficiency, bone fractures, and pneumonia.\(^\text{2–5, 10, 43, 49}\)

Puncture wounds are the most common risk factor for the disease (40%). Other exposures include lacerations, abrasions, chronic wounds, injection drug use, and diabetes. About one third of infections result from indoor injury. About 10% of infections are not associated with any of these factors and perhaps are related to an undetected puncture. Almost all recent cases of tetanus occur in un- or undervaccinated persons with a majority occurring in adults. An average of 31 cases of tetanus are reported each year.
Tetanus Wound Management

| Vaccination History | Clean, minor wounds | All other wounds |
|---------------------|---------------------|-----------------
| Unknown or less than 3 doses | Td* Yes No | Td* Yes Yes |
| 3 or more doses      | No* No            | No** No         |

* Tdap may be substituted for Td if the person has not previously received Tdap and is 10 years or older
+ Yes, if more than 10 years since last dose
++ Yes, if more than 5 years since last dose

The vaccines protecting against tetanus are contraindicated in people who have had a severe allergic reaction to a prior dose. Some older people may report an allergy to “tetanus shots.” Allergy to tetanus antitoxin used in the first half of this century does not contraindicate tetanus toxoid. Ask enough questions to distinguish between the two drugs. Defer immunization until moderate or severe acute illness improves. Adverse events that may be expected with this vaccine include injection-site reactions. Arthus immune-complex reactions with painful local swelling may occur if someone is immunized too frequently. Systemic reactions are uncommon, and severe reactions are rare.

CDC’s guidelines for wound management are provided in the table above. This table depicts the relative number of doses of Td and tetanus immune globulin (TIG) needed. This table is for reference and education only. Definitive wound management should be provided by an emergency room or similar setting, not in a pharmacy.

Diphtheria

Diphtheria is caused by Corynebacterium diphtheriae, a gram-positive, toxigenic bacillus. The disease can involve any mucous membrane: nasal, tonsillar, pharyngeal, laryngeal, cutaneous, ocular, or genital. Most commonly, exudative pharyngitis develops, forming a pseudo-membrane that may extend into the airway and cause respiratory obstruction. Complications of diphtheria include myocarditis and neuritis and are due to absorption of the bacteria’s toxin. The overall case-fatality rate is 10%, higher among children and the elderly.2–5, 10, 43, 44

Diphtheria was a common cause of death among children in the early 1900s. In several cities, community pharmacies served as community depots for diphtheria antitoxin. Because of diphtheria toxoid, the disease is now rarely seen in the United States. When infection does occur, it is more likely to be among adults. From 20% to 60% of American adults are susceptible.

Although diphtheria is rare in the United States, the disease is common in other parts of the world. A large diphtheria outbreak in the early 1990’s in Russia led to over 157,000 cases and over 5,000 deaths. In 2008, the World Health Organization (WHO) reported 7,088 cases of diphtheria.

Pertussis
Pertussis, also called whooping cough, is caused by *Bordetella pertussis*, a gram-negative bacillus. *Bordetella pertussis* is a complex organism that contains several components believed to be responsible for both the disease and immunity to the organism, such as pertussis toxin (PT), filamentous hemagglutinin (FHA), agglutinogens, adenylate cyclase, pertactin, tracheal cytotoxin, and others.2-5, 10, 13, 20, 41

Pertussis begins with a catarrhal stage: 1 to 2 weeks of cough, slight fever, and symptoms similar to a common cold. This is followed by a paroxysmal “whooping” cough persisting 1 to 6 weeks. Coughing episodes can average 15 attacks per day. An audio file of the cough can be found on www.whoopingcough.net. The whoops result from inspiratory effort against a closed glottis. The third stage is the convalescent stage. This stage can last for months as the person gradually recovers. This disease is extremely contagious, with a secondary attack rate around 90%.

On average, there have been over 15,000 cases of pertussis annually over the past five years. The state of California declared pertussis an epidemic in 2010 after over 9,000 reported cases and 10 infant deaths. Complications of pertussis include pneumonia (9%), seizures, encephalopathy, and hypoxia. About one-third of people infected with pertussis require hospitalization. Roughly 2 people die for each 1,000 pertussis infections. Complications are most common among children younger than 5 years old. Children younger than 1 year old account for half the reported cases of pertussis. Adults can be mildly symptomatic but still carry the disease and transmit it to under vaccinated infants. It is important to vaccinate preschool children and anyone in contact with infants according to the recommended routine childhood immunization schedule.

*Tetanus, Diphtheria, Pertussis Vaccines*

The vaccines to prevent tetanus, diphtheria, and pertussis can often be confusing. The use of Td, DT, Tdap, and DTaP depend largely on age and tolerability. Only acellular pertussis vaccines (DTaP, Tdap) are currently available on the US market. Prior to 2001, a whole-cell version (DTwP) was predominantly used. Concerns with safety including local injection site reactions with the whole-cell pertussis vaccine led to the development of the more purified acellular version.

The differences between DTaP and Tdap are both in the composition of the vaccine and the recommendation ages. A capital letter implies a larger concentration of the antigen. The DTaP vaccine is recommended routinely for all children (without a valid contraindication) at months 2, 4, 6, 15-18, and 4-6 years. The Tdap vaccine is recommended routinely for adolescents 11-12 years and as a one-time Td replacement for adults. People in close contact with infants should also receive a Tdap vaccination including pregnant women in the second half of their pregnancy. Pertussis vaccine is contraindicated among people who have had a serious allergic reaction to it or who developed encephalopathy within 7 days of a previous dose.
A combined tetanus-diphtheria toxoids (Td) should be used to boost adult immunity every 10 years after a primary immunizing series. The DT vaccine is available for children who cannot tolerate a pertussis containing vaccine.

Combination vaccines are available in the US that can decrease the number of injections for an infant. There are currently vaccines that include: DTaP-IPV, DTaP-HepB-IPV, DTaP-IPV/Hib.

**Varicella**

Varicella-zoster virus (VZV) is a herpes virus that causes two kinds of disease. Primary infection with VZV causes varicella (chickenpox). Before the vaccine was licensed, infection with VZV was nearly universal by age 15 years. Some 3 to 4 million people developed varicella each year. After the acute infection, the virus lies dormant in nerve root ganglia. If the viruses reactivate, usually many years later, a painful condition called herpes zoster or shingles results.²⁻⁵, ¹⁰, ²¹

Natural varicella is characterized by several hundred to more than a thousand pruritic vesicles, mostly on the trunk. Infection is spread by respiratory transmission via airborne droplets or direct contact with lesions. The virus is communicable from 1 to 2 days before to 4 to 5 days after onset of rash. The disease is very contagious. The secondary attack rate from an initial index case is about 87%. About 15% of people will develop herpes zoster at some later time after being infected with varicella-zoster virus. Reactivation of zoster is often linked with advancing age, immunosuppression, intrauterine exposure, or contracting varicella when younger than 18 months of age. Patients with zoster can transmit the virus to those susceptible to varicella.

Complications of varicella most commonly involve secondary bacterial infections of lesions, which are occasionally life threatening, such as with group A streptococci or staphylococci (especially in children). Other complications include cerebellar ataxia, encephalitis, and pneumonia (especially in adults). About 3 of every 1,000 people infected with varicella require hospitalization, with about 9,000 hospitalizations per year in the United States before vaccine introduction. About 1 in 60,000 infected people dies, roughly 50 to 100 deaths per year in this country. From 5% to 15% of adults are susceptible. Adults have a 25-fold higher death rate if infected, compared with children.

Varicella vaccine was first developed in 1974 and ultimately licensed in March 1995 in the United States. It has been widely used in Japan since the mid-1980s. A live, attenuated virus vaccine reduces the risk of
varicella by about 95%. Varicella vaccine is sensitive to temperature and is stored frozen. Inject it immediately after reconstitution. If not used, it must be discarded within 30 minutes after reconstitution. Proper storage conditions are essential to ensure vaccine potency. The VAR vaccine is indicated for children 12-15 months and 4-6 years. The varicella vaccine has been found to be 70-90% effective against any varicella disease. In general, protection after varicella immunization is long lasting. Breakthrough infections are rare and significantly milder with fewer lesions. Adverse events that can be expected after this vaccine include rash (4% to 10%), which is usually maculopapular rather than vesicular, with fewer than 50 lesions. Injection-site symptoms may occur. Fever after varicella vaccination is rare. Zoster has occurred among vaccinees but at a lower rate than after natural infection. Transmission of vaccine virus to a susceptible household contact has been reported. Transmission appears to be uncommon and may occur only if the vaccinee develops a rash. If a rash develops, the vaccinee should avoid contact with immunocompromised people.

**Shingles**

Shingles is a unilateral eruption of a rash of blisters, often associated with great pain, which occurs as a result of the re-activation of the varicella-zoster virus (VZV), the virus which causes chicken pox. Varicella zoster is a member of the Herpesviridae family of DNA viruses, including the Herpes Simplex viruses and Epstein-Barr virus (the cause of infectious mononucleosis. Once an individual is infected with varicella-zoster, the virus lies dormant in the dorsal root or cranial sensory ganglia for many years, thus anyone who has had chicken pox in the past is at risk for developing shingles later in life. Reactivation of the virus is thought to occur as a result of a decline with age in varicella-zoster specific immunity. The pain associated with varicella-zoster can occur during the prodrome (the period before the rash erupts), the acute eruptive phase, and the postherpetic phase of the infection which can last for months to years.

This first sign of shingles is often a painful or tingling sensation, or sometimes numbness, in or under the skin. Several days later, a rash of small blisters appears on the skin similar to that of chicken pox, but usually in a strip like pattern on one side of the body. Shingles is also associated with fever, headache, chills, and stomach upset. If the rash occurs on the face, hearing loss or visual impairment can result. Shingles is more common after the age of 50, and the lifetime risk of developing zoster is at least 32%.

In 2006, a live attenuated zoster vaccine (Zostavax) for the prevention of shingles in patients aged 60 years and older. The zoster vaccine is thought to boost VZV-specific immunity, thus helping to prevent shingles or lessen the symptoms of an outbreak should one occur. Zostavax (ZOS) is a subcutaneous injection given as a single dose and should not be used in children as a substitute for Varivax (VAR), the chickenpox vaccine.

The zoster vaccine is live attenuated varicella-zoster virus obtained from a child with naturally occurring varicella, then introduced into human embryonic lung cell cultures, adapted to and propagated in embryonic guinea pig cell cultures and finally propagated in human diploid cell cultures. The vaccine is kept frozen, but once reconstituted the vaccine can remain at room temperature for 30 minutes, but should be administered immediately to avoid loss of potency. It contains trace amounts of neomycin and bovine calf serum and is preservative free. Patients having anaphylactic reactions to topically or
systemically administered neomycin, or any other component of the vaccine, should not be given the vaccine. Neomycin allergy resulting in contact dermatitis is not a contraindication to use.

In clinical studies the zoster vaccine was found to be 64 percent more effective than placebo in preventing varicella zoster outbreaks in patients 60-69 years of age, and a 51 percent more effective overall. There is a possibility of patients receiving the zoster vaccine to transmit VZV to patients who have not had chickenpox in the past, and female patients should not become pregnant for at least 3 months after receiving the vaccine. Immunocompromised patients, including patients with HIV/AIDS or taking high doses of steroids, should not receive the vaccine.

The zoster vaccine is recommended by the CDC for all persons aged 60 years and older without contraindications regardless of past history of shingles. The FDA has approved the zoster vaccine for use in patients 50 years of age and older. The package insert for the vaccine would reflect this approval. The CDC declined to recommend ZOS routinely to persons 50-59 years, because of concern with unknown longevity in protection, cost-effectiveness, and supply of vaccine. They are continuing to monitor the effects of the vaccine.

**Human Papillomavirus (HPV)**

Human Papillomavirus is a family of viruses comprising over 100 different types of viruses, around 40 of which are sexually transmitted, or mucosal. The other 60 types cause warts on non-genital skin, known as common warts. Mucosal HPV can further be subdivided into high-risk and low-risk types. High-risk HPV types include HPV-16, 18, 31, 33, 39, 45, 51, 52, 56, 58, 59, 68 and 69, which can lead to the growth of cancers. Low-risk HPV types rarely develop into cancer, but like high-risk types can cause abnormal growth of cells. Low-risk types include HPV-6 and HPV-11. Most genital warts are caused by HPV-6 and HPV-11. High-risk types of HPV which result in warts usually result in flat growths that are different in appearance when compared to those cause by HPV-6 and HPV-11.

HPV is one of the most common sexually transmitted diseases, however, most people infected with HPV will show no symptoms and still be able to transmit the infection through sexual contact. HPV is transmitted through skin-to-skin contact, and it is unclear whether condom use results in protection from individuals who are infected as the infection can occur on scrotum, vulva, anus, or the skin between the anus and the genitalia, all of which are not protected by condom use. If genital warts result from infection, appearance of the warts can take many weeks or even months after sexual contact, or may never appear at all.

Most HPV infections occur without symptoms, and resolve on their own over a few years. Some, however, may persist for many years, with or without causing visible symptoms. HPV is recognized as the leading cause of cervical cancer in women, with over 11,000 women expected to be diagnosed with cervical cancer in 2008, resulting in nearly 4,000 deaths. 70% of these cancers are caused by HPV-16 or HPV-18. Even though almost all cases of cervical cancer are related to HPV, most genital infections will not cause cervical cancer. Over 6 million people will get an HPV infection every year, half of those being individuals between the ages of 15-25, and 50-75% of people who have had sex will have HPV at some point in their lives.
Men do not have the same risk of cancer with high-risk HPV types that women do. Most men will never experience symptoms or health risks if they get one or more types of high-risk HPV. However, in very rare instances, penile intraepithelial neoplasia (PIN) and penile cancer have been associated with high-risk HPV. Homosexual and bisexual men are also at risk for anal dysplasia and anal cancer, although rare, which is strongly linked with high-risk HPV. There are no screening tests for penile cancer as it is extremely rare, and currently no test for HPV in men due to the thick skin of the penis, and the fact that most men never show symptoms, thus the virus is at subclinical levels (invisible).

Women are a very different story when it comes to HPV infection. Cervical dysplasia and cervical cancer are the largest threat to women infected with high-risk HPV types. Cervical cancer is the second leading cause of death of women worldwide, and most cases of cervical cancer are linked to high-risk HPV. All women should have a pap smear completed by age 21, or three years after becoming sexually active, whichever comes first. Since cervical cancer is such a slow growing cancer, with regular pap smears it is very easy to prevent if caught early. Other conditions in which women are at increased risk due to high-risk HPV infection include anal dysplasia and anal cancer in women who engage in anal sex, vaginal intraepithelial neoplasia (VAIN) and vaginal cancer, and vulvar intraepithelial neoplasia and vulvar cancer, all of which are associated with, but not always caused by high-risk HPV.

The HPV vaccine is recommended routinely for girls aged 11-12 years. The age range and applicability to males depends on the brand product used. There are two vaccines currently available to help prevent HPV disease. The quadrivalent Human Papillomavirus (types 6, 11, 16, 18) Recombinant Vaccine, (Gardasil – Merck) was the first HPV vaccine (HPV4). A bivalent, HPV2 vaccine (types 16, 18) is also available (Cervarix – GlaxoSmithKline). The two types of HPV, 16 and 18, cause 70% of all cervical cancers, while types 6 and 11 cause 90% of all cases of genital warts.

The HPV4 vaccine is prepared from the highly purified virus-like particles (VLPs) of the major capsid protein of HPV types 6, 11, 16, and 18. The 0.5mL suspension is given in 3 separate doses at 0, 1-2, and 6 months. It is ideal to give the vaccine prior to sexual encounters. Women as early as 9 years and as late as 26 years can be start the HPV4 series. In clinical studies, HPV4 has been shown to be nearly 100% effective for the prevention of infection by HPV 6, 11, 16, and 18. It does not protect against all forms of high-risk HPV, so there is still the possibility of contracting high-risk types not covered by the vaccine. The vaccine will not protect you against HPV types in which you have already been exposed. Recent data shows that women who received the vaccine series are still producing a high immune response more than 5 years after receiving the series, but several more years are needed to see whether boosters will be needed to maintain immunity. Men can also receive HPV4. It is recommended routinely for boys aged 11-12 years for prevention of genital warts. It may be given as early as 9 years and routinely as late as 21 years. It is also permissible to give the HPV4 to males aged 22-26 years. Issues with cost-effectiveness drove the decision by the ACIP to make the male recommendations slightly different than the females.

The HPV2 vaccine is given as a 0.5mL suspension in 3 separate doses at 0, 1-2, and 6 months. According to the ACIP, either HPV2 or HPV4 may be given to females aged 9-26 to prevent cervical cancer and precancers. The HPV2 does not carry an indication for males. Both vaccines are stored in the refrigerator, 35-46°F.

**Hepatitis B**
The hepatitis B virus (HBV) is a small DNA virus that specifically infects humans. HBV is the most common cause of chronic viremia on the globe. HBV causes so much hepatocellular cancer that only tobacco is a more common known cause of cancer.\textsuperscript{2,5,42}

Hepatitis B infection develops after an incubation period of 6 weeks to 6 months. About half of these infections are asymptomatic. People infected with hepatitis B virus are contagious for 1 to 2 months before and after onset of symptoms. Asymptomatic infections are also contagious. Symptoms start with a prodromal syndrome of fever, malaise, and headache. Acute illness most obviously involves jaundice, characterized by yellow skin, yellow eyes, and dark urine. Acute manifestations can involve fulminant hepatitis in 1\% to 2\% of infected people, leading to hospitalization and high mortality risks. Chronic infection occurs in about 5\% to 10\% of infected people and can lead to cirrhosis, hepatocellular carcinoma, and death.

Over 200 million people worldwide are chronically infected with HBV. One million of these people live in the United States. The incidence of new hepatitis B infections peaked in the United States in the mid-1980s with an estimated 200,000 new infections per year. Of these, 15,000 were hospitalized, and 5,000 died. The deaths included 400 fulminant cases, 1,500 hepatocellular cancers, and 4,000 people with cirrhosis. The infection rate has changed little in recent years, and the death rate is not expected to fall for several decades.

Hepatitis B infection is largely an adolescent and adult disease, but substantial numbers of children are also infected. The distribution of new infections by age is 85\% adult, 8\% adolescent, 4\% children, and 4\% perinatal. Because of the large number of new infections, these small percentages among children still correspond to more than 12,000 infants and children. With the exception of varicella, hepatitis B is the most common vaccine-preventable disease among children. Because of this and the widespread delivery of childhood immunizations, a universal infant vaccination strategy against hepatitis B was adopted in 1991.

HBV transmission results from exposure to the blood or body fluids of an infected person. More than half of new infections result from sexual contact with an infected person (40\% heterosexual, 15\% homosexual). Injection drug use (12\%), household contact (3\%), and health care exposures (2\%) may also lead to infection. Fully one-quarter of new infections have no known risk factor to explain the infection.

The large pool of people who carry hepatitis B virus in their bloodstream is a major factor in the large number of new infections each year. The most prominent risk factor for becoming chronically infected with HBV is age at time of infection: 90\% risk if infected at birth, 50\% if infected at 1 year of age, and 10\% if infected after the fifth birthday. Disproportionately, perinatal infection accounts for 24\% of subsequent chronically infected persons.

Hepatitis B vaccines consist of purified hepatitis B surface antigen (HBsAg), a protein found on the outer viral coat. The vaccines do not contain complete viral particles and are not infectious themselves. The first such vaccine (\textit{Heptavax-B}, Merck) was produced from human serum and available from 1981 to 1991. Subsequently, recombinant HBsAg was harvested from genetically engineered brewer’s yeast.
(Saccharomyces cerevisiae). Two of these vaccines are currently licensed: Recombivax HB (Merck), first licensed in 1986, and Engerix-B (GlaxoSmithKline), introduced in 1989.

Both vaccines reduce the risk of disease by about 95% after three doses. An anti-HBs antibody titer $\geq 10$ mIU/mL after immunization is considered protective. Booster doses are not routinely recommended for anyone except for dialysis patients who have lost anti-HBs antibodies and people who are immunosuppressed. After three doses, protection seems to persist even after circulating anti-HBsAg antibodies fall to undetectable levels. This protection may be related to induction of memory lymphocytes and the long incubation period for the disease.

Give hepatitis B vaccine to all infants. Thimerosal-free formulations of hepatitis B vaccine are preferred for very young infants. Expert guidelines also call for immunization of all children and adolescents. High-risk adults who need this vaccine include health care workers, people with multiple sexual partners or sexually transmitted diseases, injection drug users, dialysis patients, hemophiliacs, some prisoners, some immigrants, and certain other groups. In 2011, the ACIP recommended that HepB vaccine be given to unvaccinated adults with diabetes mellitus aged 19-59 years and at the discretion of a clinician to people with diabetes aged 60 years and older. Vaccination is contraindicated if a severe allergic reaction occurred after an earlier dose of this vaccine.

Infants should receive their first dose of this vaccine at birth. The second dose is given at 1-2 months. The third dose should be administer no earlier than 24 weeks. Infants born of mothers positive for HBsAg need both vaccine and hepatitis B immune globulin (HBIG) promptly at birth.

Recombivax HB and Engerix-B are interchangeable, but the dosage in microgram content varies between the two brands. These differences are depicted in the table below. Note that various concentrations are available. Verify the volume to be administered to deliver the appropriate dose in micrograms. Post the doses appropriate for each age and circumstance. Other references discuss in detail postvaccination testing, handling nonresponders, and other issues.\(^2\)\(^-\)\(^5\), \(^42\)
Recommended doses of currently licensed formulations of hepatitis B vaccine, by age group and vaccine type

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Dose (µg)*</th>
<th>Volume (mL)</th>
<th>Dose (µg)*</th>
<th>Volume (mL)</th>
<th>Dose (µg)*</th>
<th>Volume (mL)</th>
<th>Dose (µg)*</th>
<th>Volume (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single-Antigen Vaccine</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Infants (&lt;1 yr)</td>
<td>5</td>
<td>0.5</td>
<td>10</td>
<td>0.5</td>
<td>5</td>
<td>0.5</td>
<td>10</td>
<td>0.5</td>
</tr>
<tr>
<td>Children (1-10 yrs)</td>
<td>5</td>
<td>0.5</td>
<td>10</td>
<td>0.5</td>
<td>5</td>
<td>0.5</td>
<td>10</td>
<td>0.5</td>
</tr>
<tr>
<td>Adolescents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-15 yrs</td>
<td>10†</td>
<td>1.0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>11-19 yrs</td>
<td>5</td>
<td>0.5</td>
<td>10</td>
<td>0.5</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Adults (≥20 yrs)</td>
<td></td>
<td></td>
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<tr>
<td>Hemodialysis patients and other immunocompromised persons</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20 yrs†</td>
<td>40‡</td>
<td>1.0</td>
<td>40‡</td>
<td>2.0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>≥20 yrs</td>
<td></td>
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</tbody>
</table>

* Recombinant hepatitis B surface antigen protein dose.
† Adult formulation administered on a 2-dose schedule.
‡ Higher doses might be more immunogenic, but no specific recommendations have been made.
§ Dialysis formulation administered on a 3-dose schedule at 0, 1, and 6 months.
¶ Two 1.0 mL doses administered at one site, on a 4-dose schedule at 0, 1, 2, and 6 months.
** Not applicable.

Remember to adjust the dose volume based on the specific package being used. Because of intermittent changes in recommended dosing or package concentrations, do not memorize this table. Post it and keep it updated. Train all personnel whenever brands are changed.

Transient adverse events that can be expected after this vaccine include injection-site pain (13% to 29%), fatigue or headache (11% to 17%), or temperature above 37.7° C (1%).

Combination vaccines for use in pediatric patients containing hepatitis B antigen also are routinely used in practice. In fact, current ACIP recommendations state that “the use of licensed combination vaccines is preferred over separate injection of their equivalent component vaccines.” However, because hepatitis B vaccine is the only vaccine recommended for use before 2 months of age, combination vaccines should not be used for the birth dose hepatitis B vaccine. These vaccines are acceptable for the second and third doses of the hepatitis B vaccine series.

Routine postvaccination serologic testing is not recommended. However, healthcare workers who have contact with blood or an ongoing risk of needlesticks should be routinely tested for antibody after 1-2 months after completing the 3-doses series.

**Hepatitis A**

Hepatitis A is an acute infection caused by a picornavirus. The virus is found in the stool of infected people and spread by fecal-oral transmission. Unlike hepatitis B, hepatitis A is rarely spread via blood products. Hepatitis A is characterized by fever, nausea, vomiting, liver inflammation, jaundice (yellowing of skin and eyes), and dark urine. The disease is more severe among adults than children but rarely leads to death. Hepatitis A does result in substantial morbidity with 11-22% of cases resulting in
hospitalization. This, coupled with missed work days and postexposure prophylaxis led to a 1989 estimated annual cost of over $200 million.  

Symptoms of hepatitis A usually last 4 weeks but can persist up to 4 months. In 1993, 75,000 hepatitis A infections were reported in the United States. Among travelers to developing countries, hepatitis A is 100 times more common than typhoid fever and 1,000 times more common than cholera.

Two vaccines are licensed which use different potency measurement systems: GlaxoSmithKline’s Havrix and Merck’s Vaqta. For each brand, the dose volume and schedule are the same, although potency is measured in different unit systems. An adult dose of Havrix consists of 1,440 ELISA units. An adult dose of Vaqta consists of 50 units, corresponding roughly to 50 ng of viral protein. Each brand provides nearly complete protection against disease.

### TABLE 2. Licensed dosages of VAQTA®

<table>
<thead>
<tr>
<th>Vaccine recipient’s age</th>
<th>Dose (U)†</th>
<th>Vol. (mL)</th>
<th>No. doses</th>
<th>Schedule (mos)§</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 mos–18 yrs</td>
<td>25</td>
<td>0.5</td>
<td>2</td>
<td>0, 6–18</td>
</tr>
<tr>
<td>&gt;19 yrs</td>
<td>50</td>
<td>1.0</td>
<td>2</td>
<td>0, 6–18</td>
</tr>
</tbody>
</table>

* Hepatitis A vaccine, inactivated, Merck & Co., Inc. (Whitehouse Station, New Jersey).
† Units.
§ 0 months represents timing of initial dose; subsequent numbers represent months after the initial dose.

### TABLE 3. Licensed dosages of HAVRIX®

<table>
<thead>
<tr>
<th>Vaccine recipient’s age</th>
<th>Dose (EL.U.)†</th>
<th>Vol. (mL)</th>
<th>No. doses</th>
<th>Schedule (mos)§</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 mos–18 yrs</td>
<td>720</td>
<td>0.5</td>
<td>2</td>
<td>0, 6–12</td>
</tr>
<tr>
<td>&gt;19 yrs</td>
<td>1,440</td>
<td>1.0</td>
<td>2</td>
<td>0, 6–12</td>
</tr>
</tbody>
</table>

* Hepatitis A vaccine, inactivated, GlaxoSmithKline (Rixensart, Belgium).
† Enzyme-linked immunosorbent assay units.
§ 0 months represents timing of initial dose; subsequent numbers represent months after the initial dose.

_CDC. Prevention of Hepatitis A Through Activeor Passive Immunization MMWR May 19, 2006;55(RR7): 10_

Immunize people traveling anywhere except Canada, Western Europe, Scandinavia, Japan, New Zealand, or Australia. Others who need vaccination include residents of communities with cyclic hepatitis A epidemics (e.g., some native people of Alaska and America). Also vaccinate homosexual men, injection drug users, laboratory workers potentially exposed to this virus, people with chronic liver disease or hemophilia, and residents and staff of institutions for disabled children, among others. Hepatitis A vaccine is not routinely recommended for health care workers, day care workers, sanitation workers, or food handlers. Local requirements for hepatitis A vaccination of food handlers are still evolving.
In October 1999, the ACIP published recommendations for hepatitis A vaccination in certain states in the US with higher rates of transmission. In 2006, the ACIP updated its recommendation to routine vaccination of children nationwide.

Hepatitis A vaccine is contraindicated among people who have had a severe allergic reaction to a prior dose. Defer immunization until after a moderate or severe acute illness improves. Adverse events that can be expected after this vaccine include transient injection-site soreness and headache. Systemic reactions are uncommon. Based on pharmacokinetic antibody models, vaccination may protect as long as 20 years or more.

For adults who need protection from both hepatitis A and hepatitis B, a combination vaccine called Twinrix (GlaxoSmithKline) may be used. Each 1 ml dose contains 720 Elu of inactivated hepatitis A virus and 20 mcg of hepatitis B surface antigen. The vaccine is administered in a 3-dose series at 0, 1, and 6 months.47

**Meningococcal Disease**

Meningococcal disease is caused by *Neisseria meningitidis*. It is an aerobic gram negative diplococcus. It is transmitted through droplets from the nasopharynx of an infected person. Meningitis and sepsis are the two major presentations of invasive meningococcal disease. Early symptoms of meningococcal meningitis include fever, headache, and stiff neck. Meningococcemia can present with a purpuric rash on the skin. The case-fatality rate of invasive meningococcal disease is 9-12%, and up to 40% with meningococcemia. Vaccination can protect against four bacterial serogroups: A, C, Y, and W-135. Unfortunately, immunization does not protect against the most common cause of meningococcal disease, serogroup B.2–5, 10, 19, 30

Now that Hib infections are controlled through immunization, *Neisseria meningitidis* is the leading cause of bacterial meningitis in children and young adults in the United States, with an estimated 2,600 infections each year. There are two kinds of meningococcal vaccine in the United States. One is Meningococcal polysaccharide vaccine (MPSV4) which consists of polysaccharides, meaning that it is not generally effective in children younger than 2 years old. MPSV4 is the only meningococcal vaccine licensed for people older than 55. Protection does not begin until 7 to 10 days after immunization. The adult and pediatric doses are the same: a single 0.5-mL dose injected SC. A Meningococcal conjugate vaccine (MCV4) was licensed in 2005 (Menactra) and a second MCV4 was licensed in 2010 (Menveo). MCV4 is the preferred vaccine for people 2 through 55 years of age. Routine vaccination is recommended of adolescents, preferably at age 11 or 12 years, with a booster dose at age 16 years. A 2-dose primary series administered 2 months apart for persons aged 2 through 54 years with persistent complement component deficiency (e.g., C5–C9, properdin, factor H, or factor D) and functional or anatomic asplenia, and for adolescents with human immunodeficiency virus (HIV) infection.

Meningococcal vaccine is used to prevent meningococcal disease in military basic trainees and in travelers to the “meningitis belt” of Africa and Asia. Evidence of immunization may be required for religious pilgrims to Saudi Arabia for the Islamic Hajj. Meningococcal vaccine is recommended for
people with asplenia, either anatomic or functional, or certain other immunodeficiencies, to reduce their risk of meningococcal infection.

Meningococcal vaccine has some value in community meningitis outbreaks. Outbreaks most commonly involve serogroup B, which is not represented in the current vaccine formulation. Although investigational meningococcal serogroup B vaccines are being tested, there are currently no vaccines against this type of outbreak. Rely on local health department advice regarding immunization during meningococcal outbreaks. In 1997, the American College Health Association (ACHA) recommended that colleges offer meningococcal vaccine to college students. The ACIP issued similar recommendations in 1999. Vaccination of these students (especially freshmen and those living in dormitories) is intended to reduce their risk of rare, but potentially fatal, disease due to Neisseria meningitidis. The rate of meningococcal disease among the general population is about 2 cases per 100,000 people per year, but among college students living in dormitories, the rate is about 4 cases per 100,000. Routine meningococcal vaccination has successfully reduced meningococcal outbreaks in military basic training settings.

**Travel Vaccines**

Pharmacists who get involved with travel health perform a valuable service, helping people who would otherwise travel without proper medical advice and the proper prophylaxis to help avoid preventable infections. Travel advice must be comprehensive, including the variety of health threats to which travelers are exposed, which may include malaria, other insect-borne diseases, injuries, and related hazards. 

While travelers usually focus on the need for protection against exotic diseases, it is no less important to check each traveler’s vulnerability to common infectious threats, too. This includes tetanus, diphtheria, poliovirus, measles, rubella, influenza, Streptococcus pneumoniae, hepatitis B, and other microbes more commonly associated with domestic life. Measles, rubella, hepatitis B, poliomyelitis, tetanus, and mumps occur far more frequently in the third world than in the United States or Canada.

Some vaccines considered above have specific travel implications (e.g., hepatitis A, meningococcal, poliovirus). Hepatitis A is perhaps the most underutilized of all travel-related vaccines; it should be used liberally in nearly all patients traveling outside of U.S. borders (see hepatitis A section for specific details). Additional vaccines are used to protect international travelers, including vaccines to protect against typhoid fever, Japanese encephalitis, and yellow fever. Parenteral cholera vaccine offers only partial, temporary protection and is no longer produced. Alternatives for typhoid-fever prevention include a four-dose series of oral typhoid vaccine capsules or a single injection of a polysaccharide typhoid vaccine. A vaccine against Japanese encephalitis is available but should only be used when the disease risk outweighs the risk of adverse vaccine effects.

Yellow fever vaccine contains attenuated live viruses. It must be stored in the freezer and is stable for only 1 hour after reconstitution. Because yellow fever vaccine is manufactured in hen eggs, refer the patient to a physician if eating eggs causes laryngeal swelling or similar severe reactions. Distribution of yellow fever vaccine is limited to sites approved by health departments.
To determine travel vaccine needs, consult detailed references. Travel immunization and malaria prophylaxis issues are complex. Refer patients to experienced travel medicine specialists for vaccine decisions.\textsuperscript{5, 52, 53}

Many infectious threats to a traveler cannot yet be prevented by vaccination (e.g., malaria, traveler’s diarrhea, schistosomiasis). As a result, travelers should avoid unsafe food, water, and insects. Standard advice about using seat belts and avoiding injury applies. A thorough travel-health consultation includes discussion of sexually transmitted diseases, blood-borne infections, bites or envenomations, water-, heat-, humidity-, altitude-, and sun-related illnesses.

Health risks are not uniform within any country, because the medical threat varies according to destination, business activities and recreation, quality of lodging, season of year, altitude, mode of travel, and other factors. International travel advice should be customized to the individual traveler’s personal needs. The proper set of vaccines needed for an individual depends on that person’s previous vaccinations, age, occupation, avocations, health status, and itinerary.

Your involvement with travel health can range from simple advice to vaccine administration. To help your traveling patients stay healthy, recommend a pre-travel health consultation and review the recommendations listed in the table below. More information for travelers can be found at http://wwwnc.cdc.gov/travel/destinations/list.htm

**Travel Health Checklist**

- Learn about the destination (e.g., accommodations, food and water quality, geography, medical services).
- Gather maps and informative documents.
- Seek expert travel-health advice 4 weeks or more before departure.
- Begin appropriate immunizations. Obtain International Certificate of Vaccination (PHS Form 731, the “yellow shot record”) and keep it with passport.
- Obtain dental check-up and medical examination (especially before prolonged travel).
- Obtain adequate supply of current prescription medication(s).
- Obtain a medical-alert bracelet for conditions such as diabetes or drug allergies.
- Purchase extra pair of eyeglasses or contact lenses, plus sunglasses.
- Collect items for travel first-aid kit (especially if traveling off usual tourist routes).
- Check health insurance plan for international coverage.
- Buy additional insurance, as needed.
Measles

Measles is caused by a member of the paramyxovirus group, the family that includes canine distemper virus. Measles is one of the most contagious diseases known, with an attack rate greater than 90%. It is spread by respiratory transmission and is communicable from 4 days before to 4 days after the characteristic rash appears. This disease typically peaks in late winter or spring.2–5,10

The classic symptoms of measles include fever of 103°F or higher, cough, coryza, conjunctivitis, Koplik spots (a white rash on mucous membranes, especially the mouth), and rash 14 days after exposure. The rash usually appears first on the face, then the trunk and legs. Complications of measles can include diarrhea (8%), otitis media (7%), pneumonia (6%, the most common cause of death from measles), encephalitis (0.1%), and death (0.2%).

Before measles vaccine was introduced, measles infected nearly everyone by 15 years of age. The first measles vaccines were introduced in 1963. The current live vaccine strain was licensed in 1968. After falling to a record low level in 1983, a resurgence of measles occurred from 1989 to 1991. More than 55,000 people with measles were reported, mostly unvaccinated preschool children. This resurgence of measles occurred mainly because low age-appropriate vaccination levels resulted in large numbers of susceptible preschool-aged children. The measles resurgence of 1989–91 led to increased efforts to vaccinate children throughout the country. These efforts have been highly successful, and measles cases have fallen to new record low levels.

Although the vaccine protects 95% of recipients, the remaining unprotected 5% of vaccinees is enough to sustain outbreaks in crowded settings, such as schools. So, in 1989, a second dose of measles vaccine, given as the trivalent measles-mumps-rubella (MMR) vaccine, was recommended. MMR is given as a 0.5-mL SC dose. The second dose is intended to protect those who did not respond to the first dose and is usually administered before entering elementary school. People born before 1957 are generally assumed to be immune to measles.

Vaccinate all children with MMR vaccine at 12 to 15 months of age, with a second dose given at 4 to 6 years of age. All children up through 18 years of age should have received two doses of MMR.

All adults born after 1956 should have at least one dose of MMR vaccine or have other evidence of measles immunity (e.g., serologic test, physician-diagnosed measles). Some adults at high risk of measles exposure should receive two doses of vaccine. This includes college students, health care workers, and international travelers who have not yet received two doses. This vaccine is contraindicated among people with a severe allergic reaction to a prior dose or severe allergic reaction to gelatin or neomycin. In the past, a severe allergy to egg protein was a contraindication to receiving measles and mumps vaccines.

Defer immunization until after a moderate or severe acute illness has improved, pregnancy, immunosuppression (except HIV), or recent receipt of antibodies or blood products. Refer children infected with HIV to their primary physician for immunization decisions. The interval to wait after antibody administration before giving a measles-containing vaccine depends on the dose of antibody given.

Adverse events that can be expected after this vaccine includes fever (5% to 15%) and rash (5%).
Encephalopathy may be temporally associated with fewer than 1 in 1 million doses of vaccine, but this event has not been proven to actually be caused by the vaccine. Most adverse effects occur among people susceptible to infection. As a result, adverse events following the second dose are very uncommon, because most recipients of second doses are already immune to measles.

**Mumps**

Mumps infection is also caused by a paramyxovirus. Mumps usually begins with a prodromal phase of headache, fever, and malaise. Classic inflammation of the parotid glands (parotitis) affects 30% to 40% of infected people, but 20% of infections are completely asymptomatic. Mumps is communicable from 3 days before to 4 days after onset of symptoms. The secondary attack rate after mumps is about 30%. \(^2\text{–}5,\,10\)

Mumps can be complicated by central nervous system (CNS) involvement (e.g., aseptic meningitis) (15%), orchitis (20% to 50% in postpubertal males), and permanent deafness. Death occurs in 1 to 3 per 10,000 infected people.

An inactivated mumps vaccine was available in 1950 but was not effective. The current live vaccine was licensed in 1968 and reduces disease rates by 95% after a single 0.5-mL SC dose. Immunize all children with MMR vaccine at 12 to 15 months of age, with a second dose given at 4 to 6 years of age. Also vaccinate susceptible adolescents and adults without documented immunity born after 1956. Healthcare workers born before 1957 without evidence of immunity should consider one dose of MMR unless in an outbreak setting where two doses is strongly encouraged. This vaccine is contraindicated among people with a prior severe allergic reaction to a prior dose or vaccine component (e.g., gelatin, neomycin). The comments about egg hypersensitivity in the measles vaccine section also pertain to mumps vaccine.

Defer immunization until after a moderate or severe acute illness has improved, pregnancy, immunosuppression (except HIV), or recent receipt of antibodies or a blood product. Refer children infected with HIV to their primary physician for immunization decisions.

Adverse events that can be expected after this vaccine include low-grade fever, parotitis (rare), rash, pruritus, and deafness (rare, temporary). Orchitis and aseptic meningitis have not been reported after mumps immunization.

**Rubella**

Rubella virus is a member of the togavirus family. Rubella itself is generally a mild disease, but there is great public health significance to controlling congenital rubella syndrome (CRS). The connection between maternal infection with rubella and birth defects such as cataracts and heart defects was first recognized in 1941. CRS can also result in deafness, microcephaly, mental retardation, bone alterations, miscarriage, and liver or spleen damage. A worldwide pandemic of rubella struck in the United States from 1963–64. In the United States, at least 30,000 infants were affected by CRS at that time, 1% of all pregnancies. These included 6,250 spontaneous abortions and over 2,100 excess neonatal deaths. Of the survivors, 11,600 were deaf, 3,580 blind, and 1,800 mentally retarded.
Rubella begins with a prodrome of low fever and malaise. Lymphadenopathy follows in the second week, with rash developing 14 to 17 days after exposure. Half of all people who develop rubella show no symptoms. The virus is spread by respiratory transmission. It is communicable from 7 days before to 5 to 7 days after rash appears. Arthralgia or arthritis complications can develop after infection. This sequela is rare among infected children, but it can affect 50% to 70% of infected adult women. Secondary thrombocytopenia purpura or encephalitis occurs rarely.

The first rubella vaccines were licensed in 1969. The current vaccine was licensed in 1979. Rubella vaccine reduces the risk of infection by about 95% with a single 0.5-mL SC dose. Immunize all children with MMR vaccine at 12 to 15 months of age, with a second dose given at 4 to 6 years of age. All children through 18 years of age should have received two doses of MMR. Also vaccinate susceptible adolescents and adults born after 1956 who do not have documented evidence of prior vaccination or serologic evidence of rubella immunity. A physician’s diagnosis or a personal history of rubella is not considered reliable evidence of rubella immunity.

Rubella vaccine is contraindicated among people who have had a severe allergic reaction to a prior dose. Defer immunization until after a moderate or severe acute illness, pregnancy, immunosuppression (except HIV), or recent receipt of antibodies or a blood product. Refer children infected with HIV to their primary physician for immunization decisions. The Vaccine in Pregnancy study conducted by the CDC from 1971 to 1989 examined the risk of congenital rubella syndrome in children born to women vaccinated early in pregnancy. Of 324 live births to such mothers, zero cases of CRS were observed. No risk of fetal damage is evident after more than 25 years of using this vaccine. To screen a woman of child-bearing age, ask if she is pregnant or likely to become pregnant in the next 3 months. Do not vaccinate her if she answers “yes.” In this case, encourage vaccination as soon as possible after delivery. Otherwise, recommend avoiding pregnancy, and vaccinate.

Adverse events that can be expected after this vaccine include rash (10%), fever, arthralgia, and arthritis. Transient joint symptoms develop in 25% to 55% of vaccinated seronegative adult women. Transient arthritis occurs in 13% to 15% of adult female vaccines. These rates are less than the risk after natural infection. Persistent joint problems after vaccination are unlikely.

**Haemophilus influenzae type b**

*Haemophilus influenzae* type b (Hib) is an aerobic gram negative coccobacillus. The bacteria’s polysaccharide capsule is responsible for virulence and also enables immunity. Before Hib vaccines were developed, Hib was the leading cause of bacterial meningitis before 5 years of age.\(^2\text{-}^5,^{10,50}\)

Invasive Hib disease includes meningitis (50% to 65%), epiglottitis (15% to 20%), pneumonia, osteomyelitis, arthritis, cellulitis, or bacteremia. Disease is spread by respiratory transmission from asymptomatic carriers. Before widespread use of Hib vaccines, from 5% to 15% of children were colonized at any given time. This led to more than 20,000 children with invasive disease and 1,000 deaths per year. Invasive Hib disease afflicted 1 of every 200 children, two-thirds before 18 months of age. Hib vaccines lowered disease incidence from 20,000 cases in 1985 to 183 in 2001.
Complications of invasive Hib infection include deafness or other neurologic sequelae in 15% to 30% of survivors. Hib had been the leading cause of acquired mental retardation. The death rate was 2% to 5% despite antibiotics.

The first Hib vaccines were purified polysaccharide vaccines licensed in 1985. Because they were composed of polysaccharides, they were not effective in children younger than 18 to 24 months of age. To overcome this limitation, the protein-conjugate vaccines were licensed in 1987.

All infants without valid contraindications should receive Hib vaccine. Two Hib conjugate vaccines are licensed for infant use, with each 0.5-mL dose given IM. They are ActHIB (Aventis Pasteur) and PedvaxHIB (Merck). A third Hib vaccine, Hiberix (GlaxoSmithKline) is approved for the last dose in the schedule for children 12 months to 4 years. The standard dosing schedule is 2, 4, 6, and 12 to 15 months of age. The dose at 6 months of age is omitted if PedvaxHIB is used for the first two doses. Children who are behind schedule may not require a full three- or four-dose series of Hib vaccine. Catch-up schedules are printed elsewhere. The brands of Hib vaccine are generally interchangeable with the exception of Hiberix. ProHIBIT (Aventis Pasteur) is only effective in people older than 15 months of age. Children younger than 24 months of age who develop invasive Hib disease do not develop immunity and should be immunized.

Hib vaccine is not routinely given to children 5 years or older. However, Hib vaccine is indicated for older children, adolescents, and adults with high-risk conditions. These include asplenia (anatomic or functional), sickle-cell disease, Hodgkin’s disease, hematologic neoplasms, severe immunocompromised unrelated to HIV infection, or solid-organ transplant or chronic immunosuppressive therapy. Consider Hib vaccine for people with HIV infection. Give adolescents and adults one 0.5-mL dose of any brand.

This vaccine is contraindicated among people who have had severe allergic reactions to a prior dose. Defer immunization until after a moderate or severe acute illness improves. Adverse events that can be expected after this vaccine include transient injection-site reactions such as swelling, redness, or pain (5% to 30%). Fever after immunization is unusual, and serious reactions are rare.
Smallpox

Smallpox is a potentially deadly disease caused by the variola virus. Due to global vaccination efforts of the WHO and many national partners, smallpox was declared eradicated in May 1980. The disease, thought to originate in Africa, India, and China was first recorded in 1350 BC and was referred to as “the speckled monster.” Epidemics in North America were reported in the 17th and 18th centuries. Smallpox belongs to the genus Orthopoxvirus, the same genus as cowpox and monkeypox. However, smallpox is the most deadly orthopoxvirus with approximately 30% of those infected dying.

The incubation period for smallpox is 12 to 14 days on average, but may be as short as 7 days or as long as 17 days. During this time there are no symptoms and the patient is usually not able to infect other individuals. Incubation is followed by a sudden onset of acute illness characterized by high fever (102°F to 106°F), malaise, headache, prostration, and severe back pain. In approximately 2 to 3 days the fever breaks and the patient feels better. It is at this time a rash appears. The patient is highly contagious about 1 day before the appearance of the rash and throughout the time of the rash.

The smallpox lesions typically appear first in the mouth mucosa, on the face, hands, and forearms. Several days later the rash will appear on the trunk. A progression of lesions from macules to papules to vesicles and then to pustules occurs approximately 8 to 14 days after onset of symptoms and then scabs form over the lesions. Scarring occurs after the scabs fall off.

Today smallpox vaccine (Dryvax—Wyeth) is a lyophilized, live vaccinia virus vaccine. Vaccine is distributed by the CDC to smallpox vaccine centers for administration. The vaccine is provided in a kit containing 100 doses of vaccine in a single vial, plus ancillary supplies including 100 individually wrapped bifurcated needles. A single drop of vaccine is placed on the tip of the bifurcated needle and then, while holding the skin of the deltoid area taught 3 or 15 (depending upon primary or revaccination) rapid and tightly concentric punctures are made to the skin. A small amount of blood must be seen after vaccination to ensure the skin as been penetrated and vaccine administered. A lesion will develop at the site of vaccination that must be protected carefully by bandaging for the approximately 3 weeks it will take for the lesion to progress from a red papule to a pustule and scabbing. Vaccinia virus can spread from the vaccination site to others until the scab has fallen away. Vaccinated people also can spread vaccinia virus to other areas of their own body through autoinoculation should the vaccine site be rubbed and then touched to other areas. Autoinoculation is most common in the eyes, mouth, nose, lips, face, genitalia, and anus. This is the reason for keeping the site of inoculation covered until the scab has completely and naturally fallen away. Due to the threat of bioterrorism using smallpox virus, the CDC has recommended a strategy of inoculating health care workers and others who might respond in the event of an outbreak of smallpox.

Since routine childhood vaccination against smallpox ceased in 1972, a large number of U.S. residents (including many health care workers) have never received a primary vaccination with smallpox vaccine and it has been well over 30 years since anyone outside of the U.S. military has received the vaccine, highlighting the vulnerability of the population. The CDC restricted its initial recommendations for immunization to: (1) smallpox response teams—those responding to investigate initial cases and initiate control measures, as well as those responsible for administering smallpox vaccine in the pre-event vaccination program, and (2) smallpox health care teams—those health care personnel from
participating hospitals who will be asked to evaluate, manage, and treat the initial suspect/diagnosed cases. The CDC does not recommend routinely vaccinating the general population against smallpox, due to the side-effect profile of smallpox vaccination. In future years the vaccine may be made available to anyone who insists upon being vaccinated or revaccinated.

Pharmacists interested in learning more about smallpox vaccine should consult the ACIP statement on smallpox vaccine, as well as ACIP’s and the U.S. Department of Defense’s subsequent updates on the vaccine (for a complete discussion www.bt.cdc.gov or www.smallpox.mil). For additional continuing education for pharmacists, an in depth discussion of smallpox vaccine, including the intricacies for screening of vaccine recipients, is available at www.pharmacist.com.

**Rotavirus**

Rotavirus belongs to the family Reoviridae, a family of undeveloped RNA viruses. Rotavirus is symmetrical with a two layer protein capsid and has a distinctive wheel-like shape. Rotavirus is environmentally stable, thus can be transmitted by ingestion of contaminated water, food, or contaminated surfaces. The primary route of transmission is the fecal-oral route, as infected individuals shed large amount of virus in their stool. In the United States, infections follow a winter seasonal pattern, with epidemics occurring form November to April.

Rotavirus is the leading cause of severe diarrhea among infants and children in the United States. There are four different strains of rotavirus common in the United States, all four of which cause diarrhea. Rotavirus gastroenteritis usually starts with upset stomach, vomiting, and fever, followed by diarrhea. The watery diarrhea can last for 3 to 7 days, which poses a serious risk for dehydration. Oral rehydration therapy is the most effective treatment to prevent dehydration, but in severe diarrhea, intravenous rehydration therapy may be required.

Worldwide, rotavirus causes over 135 million cases of diarrhea per year in children less than 5 years old, resulting in over 500,000 deaths. Children between the ages of 3 months to 3 years are at the highest risk for developing severe diarrhea. In developing countries, 1,600 deaths per day are attributed to rotavirus diarrhea.

There are two rotavirus vaccines currently available in the US (RV5 and RV1). The ACIP does not express a preference for either vaccine. The first vaccine, a live, oral, human-bovine reassortant rotavirus vaccine (RotaTeq® [RV5] - Merck) is licensed as a 3-dose series for use among U.S. infants for the prevention of rotavirus gastroenteritis. The second vaccine, a live, oral, human attenuated rotavirus vaccine (Rotarix® [RV1] – GlaxoSmithKline) is licensed as a 2-dose series for use among U.S. infants.

The rotavirus vaccine is given routinely at 2 and 4 months (and 6 months if RV5). The minimum age for the first dose is 6 weeks and the maximum age is 14 weeks 6 days. The vaccine should not be initiated in infants 15 weeks and older.

If for any reason an incomplete dose is administered (e.g., infant spits or regurgitates the vaccine), a replacement dose is not recommended, since such dosing was not studied in the clinical trials. The
infant should continue to receive any remaining doses in the recommended series. Discard the empty tube and cap in approved biological waste containers according to local regulations.

Previous rotavirus vaccines were available in US. In 1998, a tetravalent rotavirus vaccine (Rotashield – Wyeth) was approved for routine use in infants. Less than one year later, the vaccine was withdrawn from the market because of its association with intussusception, a condition affecting the intestines. The FDA and CDC continue to monitor intussusception with the currently available rotavirus vaccines.

Other Vaccines

Rabies vaccine is the only vaccine in America for which the national goal is to reduce utilization. Its low side-effect profile allows it to be used readily for postexposure protection after animal bites. Refer people with potential rabies exposures to experts in the local epizooiology of rabies virus for advice on using this vaccine. Rabies is appropriately used before possible occupational exposures (e.g., veterinarians) and for travelers to inaccessible locales.3–5, 52–54, 61

Details about these and other vaccines are published in various references. Whenever dealing with an unfamiliar immunologic drug, consult detailed references.3–5
References
