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Immunization Update

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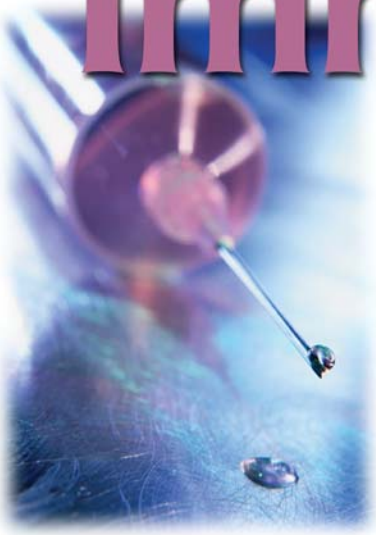

by Karl Hess, Pharm.D. and Jeffery A. Goad, Pharm.D., MPH

It is hard to imagine a world in which infectious diseases like measles, polio, and others once ran rampant. This is due in large part to the development of vaccines and the implementation of vaccination programs that have helped to curb the spread of disease. Before the introduction of the measles vaccine in 1963, nearly everyone in the United States got the disease and approximately 500 measles-associated deaths were reported each year. In contrast, with the widespread use of the measles vaccine, we saw only 62 cases of measles last year, or less than 1 case per million people.[1] Before the inactivated polio vaccine was developed in 1955, approximately 13,000 to 20,000 individuals became stricken each year with a virus that caused paralysis, disability and, sometimes death. Widespread vaccination led to the elimination of wild polio virus in the United States in 1979 and with the efforts from the Pan American Health Organization, the virus was eradicated from the western hemisphere in 1991.[2]

Immunization represents a very effective primary prevention strategy to curb the rate of vaccine preventable diseases. Nowhere is this more apparent than in the administration of the birth dose of Hepatitis B to all newborns. In general, newborns do not have the traditional risk of acquiring Hepatitis B infection, but they may when they grow up. It is important to note that primary prevention strategies reduce the incidence (i.e. new cases) of disease whereas secondary (e.g. disease screening) and tertiary (e.g. aspirin after an MI to prevent another MI) prevention strategies seek to reduce the prevalence (i.e. number of existing cases) of a disease by allowing early treatment as in the case of disease screening. Giving a pneumococcal vaccine to someone with diabetes to reduce the risk of developing a severe pneumonia is still a primary prevention strategy as the person does not yet have pneumonia.

The Advisory Committee on Immunization Practices (ACIP) was established to help determine the best use of vaccines in both the adult and pediatric populations. The ACIP statements as published in Morbidity and Mortality Weekly (MMWR) are the official CDC endorsed recommendations for use of a particular vaccine. See Table 2 for a complete list of resources for vaccine information and materials. The ACIP guidelines may differ from the vaccine's package insert. If there is a difference, standard of practice would suggest one follow the ACIP guideline over the package insert. Until the MMWR publishes the final recommendations of the ACIP, the recommendations are considered provisional and will be noted as such in this article.

Pharmacists can play a leading role in vaccination by serving as an advocate, facilitator, and active immunizer. As an advocate, pharmacists provide vaccine education while motivating people to get immunized. As a facilitator, pharmacy's can host other groups, such as the visiting nurses association, to come into the pharmacy and vaccinate. As an active immunizer, however, pharmacists serve their greatest role by giving immunizations to adolescents and adults.

Immunization schedules for children, adolescents, and adults are usually updated yearly and the most recent version should always be referenced. See figures 1 and 2 for the current 2005-2006 immunization schedules. The adult schedule has been organized into two tables to better illustrate vaccine indications. In an effort to make the adult schedule resemble the pediatric schedule, age categories are used in the first chart and indications in the second. Routine vaccines are highlighted in yellow and are above the broken line while vaccines for those with specific risk factors are highlighted purple and/or are below the broken line. Additionally, if an individual is known to have a specific medical condition, then the vaccination by medical indication chart can be used. For example, an adult with diabetes should receive a yearly influenza shot, a pneumococcal polysaccharide shot, a tetanus booster every ten years, as well as the MMR and varicella vaccines if not previously received.

The childhood and adolescent immunization schedule is organized according to age and vaccine type. Vaccines highlighted in yellow can be administered within the correspond-

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Table 1. Recent Changes in Vaccine Recommendations

Vaccine	Indication(s)	VIS Date	Change
Hepatitis A	•MSM[1] •IVDA •Chronic liver disease •Overseas travel to certain destinations	01/09/2006	New recommendation: Children starting at 1 year of age
Hepatitis B	•CA kindergarten and 7th grade entry req. •Birth to infant universal rec •Multiple sexual partners •MSM •IVDA •Health care workers •Hemodialysis patients	07/11/2001	•Universal infant vaccination •Emphasis on birth dose •Target adolescent immigrants from endemic countries
Tdap (Tetanus, diphtheria, acellular pertussis)	•Adolescents: 11-18 booster dose[2] •Adults: 19-64 booster dose[2]	09/22/2005	•Replaces next Td booster dose •Preadolescent visit (11-12 yrs)
Meningococcal	•11-12 year olds at preadolescent visit •Prior to high school entry (if not previously received) •College freshman living in dorms •Functional/anatomical asplenia •Immunocompromised	10/07/2005	•Preadolescent visit at 11-12 years emphasized •Menactra® approved for 11-55 year olds
Varicella	Children 12-18 months old	12/16/1998	New recommendations:[2] •Focus on middle school, high school, and college •All people >13 yrs without evidence of VZV as demonstrated by: oDocumentation oBorn before 1966 oHistory of VZV oHistory of shingles oPositive serology
Rabies	High risk of exposure to rabies (i.e. veterinarians/animal handlers, etc)	01/12/2006	Removal of the intradermal rabies vaccine from market, thus no need for the warning of an interaction between antimalarials and rabies vaccine in the VIS.
Inactivated Influenza	•6 mos-24 months universally recommended •> 24 mos, see Vaccine charts for indications	10/20/2005	Individuals with muscle or nerve disorders which can compromise respiratory function

[1] MSM = Men who have sex with men (new CDC classification)
[2] Provisional ACIP recommendations

ing age range while green highlights indicate the catch up age range. New to the schedule is the 11-12 year old pre-adolescent visit highlighted in purple. At this visit, prior to entering middle school, children should receive their first booster dose of tetanus, diphtheria, and pertussis (Tdap) as well as the new meningococcal (Menactra®, MCV4) vaccine. In the bottom right corner of the table are vaccines enclosed by a broken red line. These vaccines, such as hepatitis A and influenza, should be administered only in select populations. For example, hepatitis A should be given to children 2 to 18 years of age living in states and communities with higher rates of hepatitis A infection and now universally for all children between 12 and 23 months of age. Yearly influenza shots should also be administered to those children 24 months of age and older with certain chronic medical conditions (see pediatric chart for more details).

The following section will discuss updates to specific vaccine recommendations made for the 2005-2006 season.

Hepatitis A

Recommended by the ACIP in October 2005 and still considered a provisional recommendation, all children between 12 and 23 months of age should receive a two dose series of hepatitis A vaccine (Havrix® or VAQTA®).[3] This recommendation strengthens the previous one in which the hepatitis A vaccine was only recommended for those individuals 24 months to 18 years of age living in states and communities with higher rates of disease. These two doses should be administered at least 6 months apart.

Hepatitis B

The use of hepatitis B vaccine (Engerix-B® or Recombivax-HB®) is also now recommended by the ACIP for all previously unvaccinated adults that are seeking to become vaccinated regardless of risk factors (i.e. sexual contact, IVDA, health care workers). This recommendation is still considered provisional by the CDC.[4] Additionally, the hepatitis B vaccine should be administered to all newborns within 12 hours of birth as a primary prevention measure to protect against the disease in the future.[5] The use of standing orders for Hepatitis B vaccine in the hospital is highly encouraged.

Tetanus, Diphtheria and Pertussis

Two new Tdap (tetanus, diphtheria, and acellular pertussis) vaccines have recently become FDA approved: Adacel® (Aventis-Pasteur) and Boostrix® (Glaxo Smith Kline). With the rising rates of

Table 2: Immunization resources

Website	Content
National Immunization Program www.cdc.gov/nip	• Selected vaccine product updates • Childhood, adolescent, and adult immunization schedules • Vaccine information statements (http://www.cdc.gov/nip/publications/VIS/default.htm) • ACIP statements (http://www.cdc.gov/nip/ACIP/default.htm)
Centers for Disease Control and Prevention www.cdc.gov	• MMWR publications • Disease specific information
Immunization Action Collation www.immunize.org	• Vaccine product information • Vaccine safety information • Email list serve (express@immunize.org)
American Pharmacists Association www.aphanet.org	• Immunization certificate programming • Links to professional journals • Immunizing pharmacist list serve (apha-immpharm-subscribe@yahoogroups.com)
Vaccine Adverse Event Reporting System www.vaers.hhs.gov	• Adverse event reporting system for vaccine administration

pertussis and waning immunity among adults, it was apparent there needed to be adolescent and adult forms of pertussis containing vaccine. Both Tdap formulations contain less diphtheria and pertussis than the pediatric formulations (DTaP and DT), thus they cause less local reactions while still eliciting an appropriate immune response. Adacel® is indicated for individuals 11 to 64 years of age while Boostrix® is indicated for 10-18 year olds.[6,7] In June 2005, the ACIP approved recommendations for the use of Tdap booster doses in place of Td in adolescents 11-18 years of age. For individuals who have completed the primary childhood series (DTP, DTaP), a Tdap booster dose is now recommended in place of Td. The preferred age for Tdap vaccination is 11-12 years old at the pre-adolescent visit. Similarly, for 11-18 years olds who have received a booster dose of Td, a minimal interval of five years is recommended before a dose of Tdap is administered to reduce the risk of local and systemic side effects.[8] For adults aged 19 to 64, a Tdap booster dose (Adacel® only) in lieu of Td should be administered if the last dose of Td was administered more than 10 years ago. Additionally, those adults who have close contact with infants less than 12 months of age (i.e. parents, daycare workers, health care providers) can receive a single dose of Adacel® even if the last Td dose was less than 10 years ago since infants are at the highest risk for pertussis-related complications.[9] It should be noted that Tdap recommendations are provisional at this time.

Meningococcal

A meningococcal tetravalent conjugate vaccine (Menactra®, MCV4) was recently FDA approved for use in individuals aged 11 to 55 years in January 2005. This vaccine contains the four main meningococcal serogroups A, C, Y, and W-135 conjugated to 48 μg of diphtheria toxoid. Compared to the polysaccharide vaccine, Menomune® (MPSV4), the conjugated version, is expected by ACIP to have a longer duration of immunity, have the ability to boost on repeated doses, and eradicate nasal carriage of *neisseria meningitidis* as compared to the polysaccharide version with a similar level of efficacy amongst all serogroups.[10] Despite the large amount of diphtheria toxoid used in the conjugated vaccine, Menactra® is not indicated for immunization against diphtheria.[11] The ACIP recommends that MCV4 be administered to 11 and 12 year olds along with a Tdap booster dose during the suggested pre-adolescent visit where other appropriate preventative services are provided. Including vaccine administration in this visit will hopefully increase vaccination coverage rates and further emphasize the importance of the pre-adolescent visit with their primary care provider to patients and their families. For those that remain unvaccinated past their pre-adolescent visit, MCV4 should be administered prior to entering high school. Additionally, college freshman living in dorms, individuals with functional or anatomical asplenia, or those with immunosuppressive conditions should also receive Menactra® or Menomune® if Menactra® is not available for individuals aged 11-55.[11] Recently, the CDC reported five cases of Guillian-Barre Syndrome (GBS) in adolescents that received MCV4 in June, July, or November 2005.[12] The CDC, however, is urging continued vaccination since this adverse effect does not appear to be occurring in higher than expected levels and no causal relationship has been established. Individuals should be informed of the potential risk prior to immunization with MCV4 and the current vaccine information sheet reflects this potential adverse effect.

Varicella

In June 2005, the ACIP voted to expand and strengthen the use of the varicella zoster (VZV) vaccine (Varivax®) among children, adolescents and adults.[13] Again, these recommendations are provisional until the CDC publishes them in the MMWR. The current ACIP recommendations state that VZV vaccination requirements should be developed within middle school, high school, and college settings and that these requirements are regularly enforced by school officials. New criteria were also established to guide people over 13 years of age on the need for VZV vaccination (see Table 1). To aid in increasing vaccination rates, a new vaccine, MMRV (ProQuad®, Merck), was FDA approved in September 2005 and combines the Measles Mumps and Rubella (MMR) vaccine with the VZV vaccine. It can be used in place of MMR and VZV vaccines separately for primary immunization at ages 12 to 15 months and up to 12 years

of age as the 2nd dose of MMR when a 2nd dose of VZV is indicated (e.g. during a VZV outbreak).[14]

Rabies

In 2004, the intradermal (ID) rabies vaccine, Imovax®, was recalled from the market over concerns that certain lots of the vaccine were not completely inactivated and could pose the potential for adverse events in certain patient populations.[15] Recently, the manufacturer of Imovax ID voluntarily withdrew the vaccine from the market, which led to the CDC revising the rabies vaccine information sheet in January 2006 (see Table 1).

Influenza

Each year, 36,000 deaths are attributed to influenza and its secondary complication, pneumococcal pneumonia.[16,17] Immunization against these diseases remains a high priority to help prevent morbidity and mortality in high risk groups. According to the National Health Interview Survey[16], 2003 influenza vaccination rates were low for individuals with higher risk conditions (24% for 18-49 year olds, 46% for 50-64 year olds, and 66% for >65 year olds), falling well short of the Healthy People 2010 goal of 90% coverage. For pneumococcal vaccination, the 2010 goal is 90% coverage for those 65 years and older. However, the Behavioral Risk Factor Surveillance System reported a 54% immunization rate for this group in whom, unlike influenza which requires annual vaccination, most only need one shot in their lifetime.[18] It is therefore exceedingly important that all capable health care providers work to attain these goals.

There are three different strains of the influenza virus. Type A influenza can cause moderate to severe illness, is responsible for epidemics and pandemics, and can infect animals as well as humans. Type B influenza typically infects younger children causing a less severe illness than infection from type A. Type C influenza is rarely reported to infect humans. Type A viruses are further classified by the presence of hemagglutinin (H) and neuraminidase (N) surface proteins. Each year, the trivalent inactivated (TIV) and the live attenuated intranasal (LAIV) vaccines are formulated to contain two strains of influenza antigen types A and one type B. The vaccine is reformulated every year to account for changes in the virus. For the 2005-2006 year, the influenza vaccine is composed of the A/California/7/2004 (H3N2)-like, A/New Caledonia/20/99 (H1N1)-like, and B/Shanghai/361/2002-like antigens.[16]

There are three different TIV influenza vaccines currently on the market; FluZone® (Sanofi Pasteur), Fluvirin® (Chiron), and Fluarix (GSK). The LAIV is marketed under the trade name of Flumist® (MedImmune). The major difference between the TIV and LAIV vaccines is that the TIV vaccine contains inactivated virus particles whereas the LAIV vaccine contains live, attenuated viruses.

Indications for the TIV and LAIV vaccines differ and are therefore not interchangeable. The TIV vaccine should be used, for example, in individuals over 50 years of age, children 6-23 months old, residents of long term care facilities, pregnant women, individuals six months to 18 years old on chronic asprin therapy, those over six months with a chronic illness such as diabetes, asthma, or cardiovascular disease, and health care workers. In contrast, LAIV should only be used in healthy individuals between the ages of 5 and 49 years. The current CDC influenza recommendations have extended TIV vaccine use to individuals with any condition that can compromise respiratory function, handling of respiratory secretions, or that can increase the risk of aspiration (e.g. cognitive dysfunction, spinal cord injuries, seizure disorders, or other neuromuscular disorders). Individuals with allergies to eggs or other components of either vaccine should not be immunized because of the potential of anaphylactic reactions.

The LAIV vaccine must be stored at -15 ºC (5ºF) or colder, preferably in a frost-free freezer, and must be thawed before use. Alternatively, the vaccine may be thawed in the refrigerator at 2-8 ºC and used within twenty-four hours. This vaccine is temperature sensitive and after nasal spray administration, replicates at 25 ºC (the typical temperature of your nose and nasalpharynx). Replication is inhibited at temperatures of 38-39 ºC (the typical temperature of your lungs), preventing it from spreading into the lower respiratory tract and causing influenza disease. Shedding of virus particles can occur for two or more days after vaccination; however, transmission of the influenza virus from person to person does not occur except in rare instances. The most common side effects from the LAIV vaccine are rhinorrhea, nasal congestion, headaches, fever, and sore throat. The most common side effect with the TIV vaccine is mild soreness at the injection site. Fever, malaise, and myalgia may also occur with the TIV vaccine six to twelve hours after vaccination and may persist for one to two days.

Multidose vials of TIV contain thimerosal whereas single dose syringes only contain trace amounts of thimerosal. Pediatric influenza does not contain thimerosal. Concerns regarding thimerosal, a mercury containing compound, causing autism have received much public attention; however, no clear evidence to date has linked thimerosal containing vaccines with autism. Despite this, efforts are underway to further reduce the amount of thimerosal in these and other vaccines. Immunization is strongly recommended for women who are or plan to become pregnant during the influenza season since the TIV vaccine can prevent one to two hospitalizations per 1000 pregnant women immunized.[4] It should also be noted that neither the TIV nor LAIV vaccines provides protection against avian (H5N1) influenza.

Pneumoccocal Disease

The current pneumococcal polysaccharide vaccine, PPV23, (Pneumovax 23, Merck) was introduced in 1983 and is composed of twenty-three different strains of pneumococcal polysaccharide coats

of the bacteria. These strains are responsible for approximately 88% of all pneumococcal disease. Because polysaccharide vaccines are not reliably immunogenic in children under two, PPV23 is only administered to people over 2 years of age. This vaccine can be administered either intramuscularly or subcutaneously to those 65 years and older as well as in individuals over the age of two with a chronic illness (e.g. cardiovascular disease, pulmonary disease (excluding asthma) diabetes, alcoholism, cirrhosis, etc). Those with an immunosuppressive disorder such as asplenia (functional or anatomical), HIV, Hodgkin's disease, or lymphoma should also receive the vaccine. The vaccine's efficacy is approximately 60-70% and antibody levels wane over time. Therefore, one revaccination dose is recommended at least five years after the first, only for those individuals that continue to be at high risk for pneumococcal complications. Those over 65 should also receive a second dose if their first dose was administered five or more years ago and they were less than 65 at the time of the first dose. [19]

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In conclusion, vaccination is one of the most important primary prevention strategies to eliminating devastating diseases around the world and at home. Pharmacists can play an essential role in promoting and administering vaccines. For the pharmacist actively involved in promoting and administering vaccines, there are numerous resources available to help stay up-to-date. Table 2 contains a list of resources for the most authoritative information on immunizations. Vaccine recommendations can change frequently, so it is incumbent upon the pharmacist to always provide the latest information to patients and other providers.

References

1. CDC. Notifiable Diseases/Deaths in Selected Cities Weekly Information. *MMWR* 2006; 55(03): 79-90
2. CDC. Poliomyelitis prevention in the United States: introduction of a sequential vaccination schedule of inactivated poliovirus vaccine followed by oral poliovirus vaccine. Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 1997; 46(RR-3): 1-25
3. CDC. Advisory Committee on Immunization Practices (ACIP) Voted to Approve the Following Recommendations-October 2005: Provisional Recommendations for Hepatitis A Vaccination of Children. Available at http://www.cdc.gov/nip/recs/provisional_recs/hepA_child.pdf
4. CDC. Advisory Committee on Immunization Practices (ACIP) Voted to Approve the Following Recommendations-October 2005: Provisional Recommendations for Hepatitis B Vaccination of Adults. Available at http://www.cdc.gov/nip/recs/provisional_recs/hepB_adult.pdf
5. CDC. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States. Recommendations of the Advisory Committee on Immunization Practices (ACIP). Part 1: immunization of infants, children, and adolescents. *MMWR* 2005; 54(RR-16): 1-32
6. Product Information: Boostrix(R), tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine, adsorbed. GlaxoSmithKline, Research Triangle Park, NC, 2005
7. Product Information. Adacel(R), tetanus toxoid, reduced diptheria toxoid, and acellular pertussis vaccine, adsorbed. Aventis Pasteur, Swiftwater, PA, 2005
8. CDC. ACIP votes to recommend routine use of tetanus toxoid, reduced diphtheria toxoid and acellular pertussis vaccines (Tdap) for adolescents. Available at http://www.cdc.gov/nip/vaccine/tdap/tdap_child_recs.pdf
9. CDC. ACIP Votes to Recommend Use of Combined Tetanus, Diphtheria and Pertussis (Tdap) Vaccine for Adults. Available at http://www.cdc.gov/nip/vaccine/tdap/tdap_adult_recs.pdf
10. CDC. Prevention and control of meningococcal disease. Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 2005; 54(RR-7): 1-17
11. Product Information: Menactra(TM), Meningococcal (Groups A,C,Y and W-135 Polysaccharide diphtheria toxoid conjugate vaccine. Aventis Pasteur, Swiftwater, PA, USA, 2005.
12. CDC. Guillain-Barré Syndrome Among Recipients of Menactra® Meningococcal Conjugate Vaccine — United States, June—July 2005. *MMWR* 2005; 54(40);1023-1025
13. CDC. Prevention of varicella. Provisional updated ACIP recommendations for varicella vaccine use. Available at http://www.cdc.gov/nip/vaccine/varicella/varicella_acip_recs.pdf
14. Product Information. ProQuad(R), measles, mumps, rubella, and vericella vaccine live. Merck & Co, Inc, Whitehouse Station, NJ, 2005
15. CDC. Notice to readers: manufactures recall of human rabies vaccine. *MMWR* 2004; 53(dispatch); 1-2
16. Centers for Disease Control and Prevention. Prevention and Control of Influenza: Recommendations of the Advisory Committee on Immunization Practices. *MMWR* 2005; 54 (RR-8): 1-31
17. Robinson KA, Baughman W, Rothrock G, et al. Epidemiology of invasive *Streptococcus pneumoniae* infections in the United States, 1995—1998. *JAMA* 2001; 285: 1729—35.
18. Behavioral Risk Factor Surveillance System (BRFSS) available at: http://www.mass.gov/dph/bhsre/cdsp/brfss/brfss.htm
19. CDC. Prevention of pneumococcal disease: Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1997; 46(RR-08): 1-24

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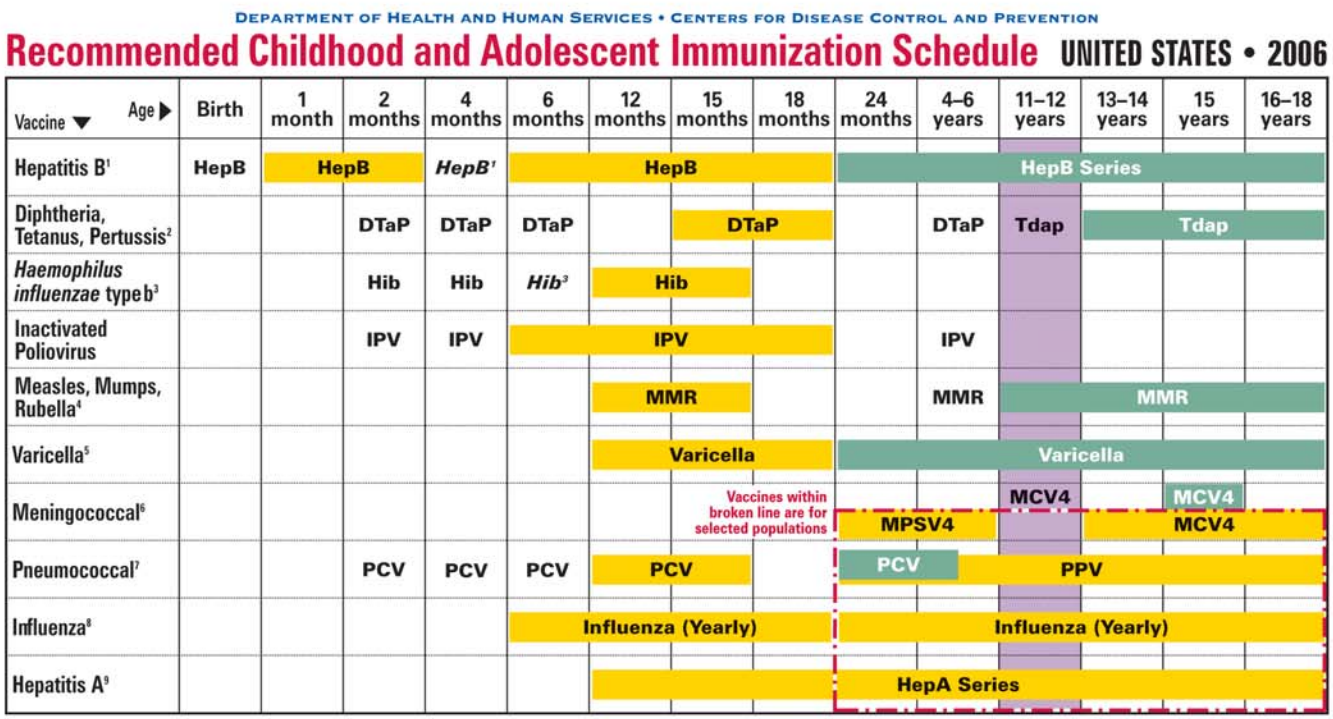
Figure 1. Child and Adolescent Immunization Schedule



This schedule indicates the recommended ages for routine administration of currently licensed childhood vaccines, as of December 1, 2005, for children through age 18 years. Any dose not administered at the recommended age should be administered at any subsequent visit when indicated and feasible. Indicates age groups that warrant special effort to administer those vaccines not previously administered. Additional vaccines may be licensed and recommended during the year. Licensed combination vaccines may be used whenever any components of the combination are indicated and other components of the vaccine are not contraindicated and if approved by the Food and Drug Administration for that dose of the series. Providers should consult the respective ACIP statement for detailed recommendations. Clinically significant adverse events that follow immunization should be reported to the Vaccine Adverse Event Reporting System (VAERS). Guidance about how to obtain and complete a VAERS form is available at www.vaers.hhs.gov or by telephone, 800-822-7967.

Range of recommended ages | Catch-up immunization | 11–12 year old assessment

1. **Hepatitis B vaccine (HepB).** ***AT BIRTH:*** **All newborns** should receive monovalent HepB soon after birth and before hospital discharge. **Infants born to mothers who are HBsAg-positive** should receive HepB and 0.5 mL of hepatitis B immune globulin (HBIG) within 12 hours of birth. **Infants born to mothers whose HBsAg status is unknown** should receive HepB within 12 hours of birth. The mother should have blood drawn as soon as possible to determine her HBsAg status; if HBsAg-positive, the infant should receive HBIG as soon as possible (no later than age 1 week). **For infants born to HBsAg-negative mothers,** the birth dose can be delayed in rare circumstances but only if a physician's order to withhold the vaccine and a copy of the mother's original HBsAg-negative laboratory report are documented in the infant's medical record. ***FOLLOWING THE BIRTHDOSE:*** The HepB series should be completed with either monovalent HepB or a combination vaccine containing HepB. The second dose should be administered at age 1–2 months. The final dose should be administered at age ≥24 weeks. It is permissible to administer 4 doses of HepB (e.g., when combination vaccines are given after the birth dose); however, if monovalent HepB is used, a dose at age 4 months is not needed. **Infants born to HBsAg-positive mothers** should be tested for HBsAg and antibody to HBsAg after completion of the HepB series, at age 9–18 months (generally at the next well-child visit after completion of the vaccine series).
2. **Diphtheria and tetanus toxoids and acellular pertussis vaccine (DTaP).** The fourth dose of DTaP may be administered as early as age 12 months, provided 6 months have elapsed since the third dose and the child is unlikely to return at age 15–18 months. The final dose in the series should be given at age ≥4 years.
   Tetanus and diphtheria toxoids and acellular pertussis vaccine (Tdap – adolescent preparation) is recommended at age 11–12 years for those who have completed the recommended childhood DTP/DTaP vaccination series and have not received a Td booster dose. Adolescents 13–18 years who missed the 11–12-year Td/Tdap booster dose should also receive a single dose of Tdap if they have completed the recommended childhood DTP/DTaP vaccination series. Subsequent **tetanus and diphtheria toxoids (Td)** are recommended every 10 years.
3. ***Haemophilus influenzae*** **type b conjugate vaccine (Hib).** Three Hib conjugate vaccines are licensed for infant use. If PRP-OMP (PedvaxHIB® or ComVax® [Merck]) is administered at ages 2 and 4 months, a dose at age 6 months is not required. DTaP/Hib combination products should not be used for primary immunization in infants at ages 2, 4 or 6 months but can be used as boosters after any Hib vaccine. The final dose in the series should be administered at age ≥12 months.
4. **Measles, mumps, and rubella vaccine (MMR).** The second dose of MMR is recommended routinely at age 4–6 years but may be administered during any visit, provided at least 4 weeks have elapsed since the first dose and both doses are administered beginning at or after age 12 months. Those who have not previously received the second dose should complete the schedule by age 11–12 years.
5. **Varicella vaccine.** Varicella vaccine is recommended at any visit at or after age 12 months for susceptible children (i.e., those who lack a reliable history of chickenpox). Susceptible persons aged ≥13 years should receive 2 doses administered at least 4 weeks apart.
6. **Meningococcal vaccine (MCV4).** Meningococcal conjugate vaccine (MCV4) should be given to all children at the 11–12 year old visit as well as to unvaccinated adolescents at high school entry (15 years of age). Other adolescents who wish to decrease their risk for meningococcal disease may also be vaccinated. All college freshmen living in dormitories should also be vaccinated, preferably with MCV4, although **meningococcal polysaccharide vaccine (MPSV4)** is an acceptable alternative. Vaccination against invasive meningococcal disease is recommended for children and adolescents aged ≥2 years with terminal complement deficiencies or anatomic or functional asplenia and certain other high risk groups (see *MMWR* 2005;54 [RR-7]:1-21); use MPSV4 for children aged 2–10 years and MCV4 for older children, although MPSV4 is an acceptable alternative.
7. **Pneumococcal vaccine.** The heptavalent **pneumococcal conjugate vaccine (PCV)** is recommended for all children aged 2–23 months and for certain children aged 24–59 months. The final dose in the series should be given at age ≥12 months. **Pneumococcal polysaccharide vaccine (PPV)** is recommended in addition to PCV for certain high-risk groups. See *MMWR* 2000; 49(RR-9):1-35.
8. **Influenza vaccine.** Influenza vaccine is recommended annually for children aged ≥6 months with certain risk factors (including, but not limited to, asthma, cardiac disease, sickle cell disease, human immunodeficiency virus [HIV], diabetes, and conditions that can compromise respiratory function or handling of respiratory secretions or that can increase the risk for aspiration), healthcare workers, and other persons (including household members) in close contact with persons in groups at high risk (see *MMWR* 2005;54[RR-8]:1-55). In addition, healthy children aged 6–23 months and close contacts of healthy children aged 0–5 months are recommended to receive influenza vaccine because children in this age group are at substantially increased risk for influenza-related hospitalizations. For healthy persons aged 5–49 years, the intranasally administered, live, attenuated influenza vaccine (LAIV) is an acceptable alternative to the intramuscular trivalent inactivated influenza vaccine (TIV). See *MMWR* 2005;54(RR-8):1-55. Children receiving TIV should be administered a dosage appropriate for their age (0.25 mL if aged 6–35 months or 0.5 mL if aged ≥3 years). Children aged ≤8 years who are receiving influenza vaccine for the first time should receive 2 doses (separated by at least 4 weeks for TIV and at least 6 weeks for LAIV).
9. **Hepatitis A vaccine (HepA).** HepA is recommended for all children at 1 year of age (i.e., 12–23 months). The 2 doses in the series should be administered at least 6 months apart. States, counties, and communities with existing HepA vaccination programs for children 2–18 years of age are encouraged to maintain these programs. In these areas, new efforts focused on routine vaccination of 1-year-old children should enhance, not replace, ongoing programs directed at a broader population of children. HepA is also recommended for certain high risk groups (see *MMWR* 1999; 48[RR-12]1-37).

The Childhood and Adolescent Immunization Schedule is approved by:
Advisory Committee on Immunization Practices www.cdc.gov/nip/acip • American Academy of Pediatrics www.aap.org • American Academy of Family Physicians www.aafp.org

Recommended Immunization Schedule for Children and Adolescents Who Start Late or Who Are More Than 1 Month Behind

UNITED STATES • 2006

The tables below give catch-up schedules and minimum intervals between doses for children who have delayed immunizations. There is no need to restart a vaccine series regardless of the time that has elapsed between doses. Use the chart appropriate for the child's age.

CATCH-UP SCHEDULE FOR CHILDREN AGED 4 MONTHS THROUGH 6 YEARS

Vaccine	Minimum Age for Dose 1	Minimum Interval Between Doses			
		Dose 1 to Dose 2	Dose 2 to Dose 3	Dose 3 to Dose 4	Dose 4 to Dose 5
Diphtheria, Tetanus, Pertussis	6 wks	4 weeks	4 weeks	6 months	6 months[1]
Inactivated Poliovirus	6 wks	4 weeks	4 weeks	4 weeks[2]	
Hepatitis B[3]	Birth	4 weeks	8 weeks (and 16 weeks after first dose)		
Measles, Mumps, Rubella	12 mo	4 weeks[4]			
Varicella	12 mo				
Haemophilus influenzae type b[5]	6 wks	4 weeks if first dose given at age <12 months 8 weeks (as final dose) if first dose given at age 12-14 months No further doses needed if first dose given at age ≥15 months	4 weeks[6] if current age <12 months 8 weeks (as final dose)[6] if current age ≥12 months and second dose given at age <15 months No further doses needed if previous dose given at age ≥15 mo	8 weeks (as final dose) This dose only necessary for children aged 12 months–5 years who received 3 doses before age 12 months	
Pneumococcal[7]	6 wks	4 weeks if first dose given at age <12 months and current age <24 months 8 weeks (as final dose) if first dose given at age ≥12 months or current age 24–59 months No further doses needed for healthy children if first dose given at age ≥24 months	4 weeks if current age <12 months 8 weeks (as final dose) if current age ≥12 months No further doses needed for healthy children if previous dose given at age ≥24 months	8 weeks (as final dose) This dose only necessary for children aged 12 months–5 years who received 3 doses before age 12 months	

CATCH-UP SCHEDULE FOR CHILDREN AGED 7 YEARS THROUGH 18 YEARS

Vaccine	Minimum Interval Between Doses		
	Dose 1 to Dose 2	Dose 2 to Dose 3	Dose 3 to Booster Dose
Tetanus, Diphtheria[8]	4 weeks	6 months	6 months if first dose given at age <12 months and current age <11 years; otherwise 5 years
Inactivated Poliovirus[9]	4 weeks	4 weeks	IPV[2,9]
Hepatitis B	4 weeks	8 weeks (and 16 weeks after first dose)	
Measles, Mumps, Rubella	4 weeks		
Varicella[10]	4 weeks		

1. **DTaP.** The fifth dose is not necessary if the fourth dose was administered after the fourth birthday.
2. **IPV.** For children who received an all-IPV or all-oral poliovirus (OPV) series, a fourth dose is not necessary if third dose was administered at age ≥4 years. If both OPV and IPV were administered as part of a series, a total of 4 doses should be given, regardless of the child's current age.
3. **HepB.** Administer the 3-dose series to all children and adolescents <19 years of age if they were not previously vaccinated.
4. **MMR.** The second dose of MMR is recommended routinely at age 4–6 years but may be administered earlier if desired.
5. **Hib.** Vaccine is not generally recommended for children aged ≥5 years.
6. **Hib.** If current age <12 months and the first 2 doses were PRP-OMP (PedvaxHIB® or ComVax® [Merck]), the third (and final) dose should be administered at age 12–15 months and at least 8 weeks after the second dose.
7. **PCV.** Vaccine is not generally recommended for children aged ≥5 years.
8. **Td.** Adolescent tetanus, diphtheria, and pertussis vaccine (Tdap) may be substituted for any dose in a primary catch-up series or as a booster if age appropriate for Tdap. A five-year interval from the last Td dose is encouraged when Tdap is used as a booster dose. See ACIP recommendations for further information.
9. **IPV.** Vaccine is not generally recommended for persons aged ≥18 years.
10. **Varicella.** Administer the 2-dose series to all susceptible adolescents aged ≥13 years.

Report adverse reactions to vaccines through the federal Vaccine Adverse Event Reporting System. For information on reporting reactions following immunization, please visit www.vaers.hhs.gov or call the 24-hour national toll-free information line 800-822-7967. Report suspected cases of vaccine-preventable diseases to your state or local health department.

For additional information about vaccines, including precautions and contraindications for immunization and vaccine shortages, please visit the National Immunization Program Website at www.cdc.gov/nip or contact 800-CDC-INFO (800-232-4636) (In English, En Español — 24/7)

Figure 2. Adult Immunization Schedule

Recommended Adult Immunization Schedule, by Vaccine and Age Group

UNITED STATES, OCTOBER 2005–SEPTEMBER 2006

Vaccine ▼ / Age group ▶	19–49 years	50–64 years	≥ 65 years
Tetanus, diphtheria (Td)[1]*	1-dose booster every 10 yrs		
Measles, mumps, rubella (MMR)[2]*	1or 2 doses	1 dose	
Varicella[3]*	2 doses (0, 4–8 wks)	2 doses (0, 4–8 wks)	
Vaccines below broken line are for selected populations			
Influenza[4]*	1 dose annually	1 dose annually	
Pneumococcal (polysaccharide)[5,6]	1–2 doses		1 dose
Hepatitis A[7]*	2 doses (0, 6–12 mos, or 0, 6–18 mos)		
Hepatitis B[8]*	3 doses (0, 1–2, 4–6 mos)		
Meningococcal[9]	1 or more doses		

NOTE: These recommendations must be read along with the footnotes.

*Covered by the Vaccine Injury Compensation Program.

For all persons in this category who meet the age requirements and who lack evidence of immunity (e.g., lack documentation of vaccination or have no evidence of prior infection)

Recommended if some other risk factor is present (e.g., based on medical, occupational, lifestyle, or other indications)

This schedule indicates the recommended age groups and medical indications for routine administration of currently licensed vaccines for persons aged ≥19 years. Licensed combination vaccines may be used whenever any components of the combination are indicated and when the vaccine's other components are not contraindicated. For detailed recommendations, consult the manufacturers' package inserts and the complete statements from the ACIP (www.cdc.gov/nip/publications/acip-list.htm).

Report all clinically significant postvaccination reactions to the Vaccine Adverse Event Reporting System (VAERS). Reporting forms and instructions on filing a VAERS report are available by telephone, 800-822-7967, or from the VAERS website at www.vaers.hhs.gov.

Information on how to file a Vaccine Injury Compensation Program claim is available at www.hrsa.gov/osp/vicp or by telephone, 800-338-2382. To file a claim for vaccine injury, contact the U.S. Court of Federal Claims, 717 Madison Place, N.W., Washington D.C. 20005, telephone 202-357-6400.

Additional information about the vaccines listed above and contraindications for vaccination is also available at www.cdc.gov/nip or from the CDC-INFO Contact Center at 800-CDC-INFO (232-4636) in English and Spanish, 24 hours a day, 7 days a week.

Recommended Adult Immunization Schedule, by Vaccine and Medical and Other Indications

UNITED STATES, OCTOBER 2005–SEPTEMBER 2006

Vaccine ▼ / Indication ▶	Pregnancy	Congenital immunodeficiency; leukemia;[10] lymphoma; generalized malignancy; cerebrospinal fluid leaks; therapy with alkylating agents, antimetabolites, radiation, or high-dose, long-term corticosteroids	Diabetes; heart disease; chronic pulmonary disease; chronic liver disease, including chronic alcoholism	Asplenia[10] (including elective splenectomy and terminal complement component deficiencies)	Kidney failure, end-stage renal disease, recipients of hemodialysis or clotting factor concentrates	Human immunodeficiency virus (HIV) infection[2,10]	Healthcare workers
Tetanus, diphtheria (Td)[1]*	1-dose booster every 10 yrs						
Measles, mumps, rubella (MMR)[2]*			1 or 2 doses				
Varicella[3]*			2 doses (0, 4–8 wks)				2 doses
Influenza[4]*	1 dose annually			1 dose annually	1 dose annually		
Pneumococcal (polysaccharide)[5,6]	1–2 doses	1–2 doses					1–2 doses
Hepatitis A[7]*	2 doses (0, 6–12 mos, or 0, 6–18 mos)						
Hepatitis B[8]*	3 doses (0, 1–2, 4–6 mos)				3 doses (0, 1–2, 4–6 mos)		
Meningococcal[9]	1 dose			1 dose	1 dose		

NOTE: These recommendations must be read along with the footnotes.

*Covered by the Vaccine Injury Compensation Program.

For all persons in this category who meet the age requirements and who lack evidence of immunity (e.g., lack documentation of vaccination or have no evidence of prior infection)

Recommended if some other risk factor is present (e.g., based on medical, occupational, lifestyle, or other indications)

Contraindicated

Approved by the Advisory Committee on Immunization Practices (ACIP), the American College of Obstetricians and Gynecologists (ACOG), and the American Academy of Family Physicians (AAFP)

Footnotes

Recommended Adult Immunization Schedule, UNITED STATES, OCTOBER 2005–SEPTEMBER 2006

1. **Tetanus and Diphtheria (Td) vaccination.** Adults with uncertain histories of a complete primary vaccination series with diphtheria and tetanus toxoid-containing vaccines should receive a primary series using combined Td toxoid. A primary series for adults is 3 doses; administer the first 2 doses at least 4 weeks apart and the third dose 6–12 months after the second. Administer 1 dose if the person received the primary series and if the last vaccination was received ≥10 years previously. Consult ACIP statement for recommendations for administering Td as prophylaxis in wound management (www.cdc.gov/mmwr/preview/mmwrhtml/00041645.htm). The American College of Physicians Task Force on Adult Immunization supports a second option for Td use in adults: a single Td booster at age 50 years for persons who have completed the full pediatric series, including the teenage/young adult booster. A newly licensed tetanus-diphtheria-acellular pertussis vaccine is available for adults. ACIP recommendations for its use will be published.
2. **Measles, Mumps, Rubella (MMR) vaccination.** *Measles component:* adults born before 1957 can be considered immune to measles. Adults born during or after 1957 should receive ≥1 dose of MMR unless they have a medical contraindication, documentation of ≥1 dose, history of measles based on healthcare provider diagnosis, or laboratory evidence of immunity. A second dose of MMR is recommended for adults who 1) were recently exposed to measles or in an outbreak setting, 2) were previously vaccinated with killed measles vaccine, 3) were vaccinated with an unknown type of measles vaccine during 1963–1967, 4) are students in postsecondary educational institutions, 5) work in a healthcare facility, or 6) plan to travel internationally. Withhold MMR or other measles-containing vaccines from HIV-infected persons with severe immunosuppression. *Mumps component:* 1 dose of MMR vaccine should be adequate for protection for those born during or after 1957 who lack a history of mumps based on healthcare provider diagnosis or who lack laboratory evidence of immunity. *Rubella component:* administer 1 dose of MMR vaccine to women whose rubella vaccination history is unreliable or who lack laboratory evidence of immunity. For women of childbearing age, regardless of birth year, routinely determine rubella immunity and counsel women regarding congenital rubella syndrome. Do not vaccinate women who are pregnant or might become pregnant within 4 weeks of receiving the vaccine. Women who do not have evidence of immunity should receive MMR vaccine upon completion or termination of pregnancy and before discharge from the healthcare facility.
3. **Varicella vaccination.** Varicella vaccination is recommended for all adults without evidence of immunity to varicella. Special consideration should be given to those who 1) have close contact with persons at high risk for severe disease (healthcare workers and family contacts of immunocompromised persons) or 2) are at high risk for exposure or transmission (e.g., teachers of young children; child care employees; residents and staff members of institutional settings, including correctional institutions; college students; military personnel; adolescents and adults living in households with children; nonpregnant women of childbearing age; and international travelers). Evidence of immunity to varicella in adults includes any of the following: 1) documented age-appropriate varicella vaccination (i.e., receipt of 1 dose before age 13 years or receipt of 2 doses [administered at least 4 weeks apart] after age 13 years); 2) born in the United States before 1966; 3) history of varicella disease based on healthcare provider diagnosis or self- or parental report of typical varicella disease for non–U.S.-born persons born before 1966 and all persons born during 1966–1997 (for a patient reporting a history of an atypical, mild case, healthcare providers should seek either an epidemiologic link with a typical varicella case or evidence of laboratory confirmation, if it was performed at the time of acute disease); 4) history of herpes zoster based on healthcare provider diagnosis; or 5) laboratory evidence of immunity. Do not vaccinate women who are pregnant or might become pregnant within 4 weeks of receiving the vaccine. Assess pregnant women for evidence of varicella immunity. Women who do not have evidence of immunity should receive dose 1 of varicella vaccine upon completion or termination of pregnancy and before discharge from the healthcare facility. Dose 2 should be given 4–8 weeks after dose 1.
4. **Influenza vaccination.** *Medical indications:* chronic disorders of the cardiovascular or pulmonary systems, including asthma; chronic metabolic diseases, including diabetes mellitus, renal dysfunction, hemoglobinopathies, or immunosuppression (including immunosuppression caused by medications or by HIV); any condition (e.g., cognitive dysfunction, spinal cord injury, seizure disorder or other neuromuscular disorder) that compromises respiratory function or the handling of respiratory secretions or that can increase the risk of aspiration; and pregnancy during the influenza season. No data exist on the risk for severe or complicated influenza disease among persons with asplenia; however, influenza is a risk factor for secondary bacterial infections that can cause severe disease among persons with asplenia. *Occupational indications:* healthcare workers and employees of long-term care and assisted living facilities. *Other indications:* residents of nursing homes and other long-term care and assisted living facilities; persons likely to transmit influenza to persons at high risk (i.e., in-home household contacts and caregivers of children birth through 23 months of age, or persons of all ages with high-risk conditions); and anyone who wishes to be vaccinated.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

Footnotes

Recommended Adult Immunization Schedule, UNITED STATES, OCTOBER 2005–SEPTEMBER 2006

For healthy nonpregnant persons aged 5–49 years without high-risk conditions who are not contacts of severely immunocompromised persons in special care units, intranasally administered influenza vaccine (FluMist®) may be administered in lieu of inactivated vaccine.

5. **Pneumococcal polysaccharide vaccination.** *Medical indications:* chronic disorders of the pulmonary system (excluding asthma); cardiovascular diseases; diabetes mellitus; chronic liver diseases, including liver disease as a result of alcohol abuse (e.g.,cirrhosis); chronic renal failure or nephrotic syndrome; functional or anatomic asplenia (e.g., sickle cell disease or splenectomy [if elective splenectomy is planned, vaccinate at least 2 weeks before surgery]); immunosuppressive conditions (e.g., congenital immunodeficiency, HIV infection [vaccinate as close to diagnosis as possible when CD4 cell counts are highest], leukemia, lymphoma, multiple myeloma, Hodgkin disease, generalized malignancy, organ or bone marrow transplantation); chemotherapy with alkylating agents, antimetabolites, or high-dose, long-term corticosteroids; and cochlear implants. *Other indications:* Alaska Natives and certain American Indian populations; residents of nursing homes and other long-term care facilities.
6. **Revaccination with pneumococcal polysaccharide vaccine.** One-time revaccination after 5 years for persons with chronic renal failure or nephrotic syndrome; functional or anatomic asplenia (e.g., sickle cell disease or splenectomy); immunosuppressive conditions (e.g., congenital immunodeficiency, HIV infection, leukemia, lymphoma, multiple myeloma, Hodgkin disease, generalized malignancy, organ or bone marrow transplantation); or chemotherapy with alkylating agents, antimetabolites, or high-dose, long-term corticosteroids. For persons aged ≥65 years, one-time revaccination if they were vaccinated ≥5 years previously and were aged <65 years at the time of primary vaccination.
7. **Hepatitis A vaccination.** *Medical indications:* persons with clotting factor disorders or chronic liver disease. *Behavioral indications:* men who have sex with men or users of illegal drugs. *Occupational indications:* persons working with hepatitis A virus (HAV)-infected primates or with HAV in a research laboratory setting. *Other indications:* persons traveling to or working in countries that have high or intermediate endemicity of hepatitis A (for list of countries, visit www.cdc.gov/travel/diseases.htm#hepa) as well as any person wishing to obtain immunity. Current vaccines should be given in a 2-dose series at either 0 and 6–12 months, or 0 and 6–18 months. If the combined hepatitis A and hepatitis B vaccine is used, administer 3 doses at 0, 1, and 6 months.
8. **Hepatitis B vaccination.** *Medical indications:* hemodialysis patients (use special formulation [40 μg/mL] or two 20-μg/mL doses) or patients who receive clotting factor concentrates. *Occupational indications:* healthcare workers and public-safety workers who have exposure to blood in the workplace; and persons in training in schools of medicine, dentistry, nursing, laboratory technology, and other allied health professions. *Behavioral indications:* injection-drug users; persons with more than one sex partner in the previous 6 months; persons with a recently acquired sexually transmitted disease (STD); and men who have sex with men. *Other indications:* household contacts and sex partners of persons with chronic hepatitis B virus (HBV) infection; clients and staff of institutions for the developmentally disabled; all clients of STD clinics; inmates of correctional facilities; or international travelers who will be in countries with high or intermediate prevalence of chronic HBV infection for >6 months (for list of countries, visit www.cdc.gov/travel/diseases.htm#hepa).
9. **Meningococcal vaccination.** *Medical indications:* adults with anatomic or functional asplenia, or terminal complement component deficiencies. *Other indications:* first-year college students living in dormitories; microbiologists who are routinely exposed to isolates of *Neisseria meningitidis;* military recruits; and persons who travel to or reside in countries in which meningococcal disease is hyperendemic or epidemic (e.g., the "meningitis belt" of sub-Saharan Africa during the dry season [Dec–June]), particularly if contact with the local populations will be prolonged. Vaccination is required by the government of Saudi Arabia for all travelers to Mecca during the annual Hajj. Meningococcal conjugate vaccine is preferred for adults meeting any of the above indications who are aged ≤55 years, although meningococcal polysaccharide vaccine (MPSV4) is an acceptable alternative. Revaccination after 5 years may be indicated for adults previously vaccinated with MPSV4 who remain at high risk for infection (e.g., persons residing in areas in which disease is epidemic).
10. **Selected conditions for which *Haemophilus influenzae* type b (Hib) vaccine may be used.** *Haemophilus influenzae* type b conjugate vaccines are licensed for children aged 6 weeks–71 months. No efficacy data are available on which to base a recommendation concerning use of Hib vaccine for older children and adults with the chronic conditions associated with an increased risk for Hib disease. However, studies suggest good immunogenicity in patients who have sickle cell disease, leukemia, or HIV infection, or have had splenectomies; administering vaccine to these patients is not contraindicated.

**Approved by the Advisory Committee on Immunization Practices (ACIP),
the American College of Obstetricians and Gynecologists (ACOG), and the American Academy of Family Physicians (AAFP)**