NCC Pediatrics Continuity Clinic Curriculum: **Immunizations** *Faculty Guide*

Goal:

To understand the pediatric immunization schedule—a component of the AAP Periodicity Schedule— and become familiar with special immunization cases.

Pre-Meeting Preparation:

- Review the following enclosures:
  - Peds in Review, 2015. "Immunizations: Vaccinations in General"
  - Recommended Child and Adolescent Immunization Schedule, 2021
  - AAP News, "Health Officials, AAP urge COVID-19 vaccination. . .". ."
- Prepare an example of a **"Vaccine Myth or Misconception"** and your thoughts about how to respond to a parent who has these concerns. *You may use the Extra-credit links or your own experiences as a guide.*

Conference Agenda:

- Complete "Immunization Cases"
- **Round-table discussion** of "Vaccine Myths & Misconceptions"—*each resident should list their example; the group should help offer ways to counsel parents.*
- **Optional:** Review how to transcribe immunizations in AHLTA.

Extra-Credit:

- CDC- Vaccine Safety Concerns; CDC- Parents" FAQ's
- Vaccine Safety: Medical Contraindications, Myths, and Risk Communication *(PIR, 2015)*
- AAP & Immunizations *(vaccine-preventable diseases, vaccines & safety, etc.)*
- ACIP Vaccine Abbreviations & Trade Names *(good for decoding shot records)*
- Rationale for the Immunization Schedule:: Why Is It the Way It Is? *(PIR, 2019)*
- Children and COVID-19 Vaccination Trends *(AAP, July 28, 2021)*

Immunizations: Vaccinations in General

Catherine C. Wiley, MD*

**Associate Professor of Pediatrics, University of Connecticut School of Medicine, Connecticut Children's Medical Center, Hartford, CT.*

Educational Gap

Despite the great success of the national childhood immunization program, gaps in coverage remain, and vaccine-preventable diseases continue to occur.

Objectives

After completing this article, readers should be able to:

1. Describe the indications, contraindications, and schedule for each of the routine childhood immunizations.
2. Recognize the enhanced immunogenicity of conjugate vaccines.

INTRODUCTION

Immunization is one of the most frequent, complex, and costly activities in the pediatric office. The routine childhood immunization schedule published by the Centers for Disease Control and Prevention (CDC) has burgeoned from vaccines protecting against nine diseases, supplemented by one-half page of explanatory footnotes, 2 decades ago to 16 diseases, three pages of footnotes, and a host of combination vaccines in 2014. Although electronic health record decision support holds promise for streamlining vaccine administration, currently pediatricians must rely on intimate knowledge of immunizations and ready access to resources that address the nuances of the schedule and other special considerations such as contraindications and precautions.

This article reviews the routine childhood vaccine schedule, contraindications and precautions to immunization, and common special considerations in immunization. A full discussion of special circumstances and high-risk populations is beyond the scope of this review. A companion article in this issue of *Pediatrics in Review* — "Vaccine Safety: Medical Contraindications, Myths and Risk Communication," by Dr Michael Smith — addresses vaccine hesitancy and catch-up schedules for unimmunized and underimmunized children.

GENERAL CONCEPTS

The childhood immunization schedule is reviewed, updated, and approved annually by the Advisory Committee on Immunization Practices (ACIP), the American Academy of Pediatrics, and the American Academy of Family Practice. The schedule is published annually in the *Morbidity and Mortality Weekly Report*. The CDC Recommended Immunization Schedule for Persons Aged 0 through 18

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years – United States 2015, catch-up schedules, and adult immunization schedules are available at www.cdc.gov/vaccines/schedules. The recommended schedule takes into account available evidence regarding vaccine efficacy and safety, immunogenicity (including persistence of passive maternal antibody), and disease prevalence. Although standard recommended intervals should be followed routinely to maximize protection, minimal intervals may be used to "catch up" children with delayed immunizations or if there is concern that a child may not return.

Timeliness of immunization is a challenge. A 2002 study demonstrated that by the age of 24 months, approximately 90% of children had received at least one vaccine late or too early to be considered valid. (1) When immunization is delayed, no routine immunization dose needs to be repeated. For immunizations administered too early, the dose should be repeated at the recommended minimum age and interval following the invalid dose. In accordance with ACIP guidelines, vaccines given within a grace period of 4 or fewer days below the minimum interval may be accepted as valid, but local and state regulations may not recognize this exception.

Most vaccines may be administered simultaneously, but when live vaccines are not given simultaneously, administrations should be separated by at least 28 days. Antigenic content of various vaccine products varies and evidence concerning the interchangeability of products is limited. The same product should be continued if practical, but vaccines should not be delayed if the same product is not available.

Other than local reactions and fever, adverse events to immunization are relatively rare. Parents should be counseled about possible adverse events and provided with the current Vaccine Information Statements published by the CDC. Significant adverse events should be reported to the CDC through the Vaccine Adverse Event Reporting System. (2)

Vaccines should not be administered in the presence of a true contraindication. Only one contraindication is common to all vaccines: anaphylaxis to a previous dose or vaccine component. When a precaution is present, immunization is generally deferred. However, vaccines may be given if the benefit outweighs the risk (eg, community outbreak). The only precaution to all vaccines is moderate-to-severe acute illness at the time that the immunization is due. In these situations, immunization may resume as the acute illness begins to resolve. Deferring vaccines in the absence of true contraindications or precautions (eg, during minor illness) is an important cause of missed opportunities for immunization.

Most routine childhood vaccines contain inactivated subunit antigens or toxins. The introduction of conjugate vaccine technology has been an important advance in the protection of children younger than 2 years of age as well as immunocompromised individuals. Bacterial polysaccharides, which are poorly immunogenic in younger children, are conjugated to carrier proteins (typically capsular or outer membrane antigens). These proteins improve immune responsivity by triggering T-cell-dependent immunity to polysaccharides, thereby strengthening immune memory.

Live attenuated vaccines include vaccines against measles-mumps-rubella (MMR), varicella, rotavirus, and influenza. Live vaccines generally induce stronger mucosal immunity than inactivated products. Because viral replication occurs, live vaccines are generally contraindicated in immunocompromised patients, in pregnancy, and following recent receipt of antibody-containing blood products (up to 11 months, depending on the dose of antibody received).

INFLUENZA VACCINES

Immunization against influenza poses unique challenges because of the changing circulation of antigenically distinct influenza viruses from year to year. Antigenic drift, due to continual minor influenza virus mutations, is particularly common among influenza A strains. In contrast, antigenic shift introduces a markedly novel influenza strain following a sudden major change in antigens to which there is little or no preexisting immunity in the population. (3) Antigenic shift is much less common than antigenic drift but has the potential to result in pandemics (eg, Spanish flu of 1918 and H1N1 in 2009).

Influenza vaccine is developed annually based on the antigenic composition of strains predicted to circulate most widely in the coming year. Trivalent vaccine historically included one B strain and two A strain lineages. Beginning with the 2013-2014 season, quadrivalent influenza vaccine became available to cover both influenza B strain lineages. In the prior 10 years, the circulating B strain was included in the trivalent vaccine in only 50% of seasons. (3) Quadrivalent influenza vaccines eventually should replace trivalent vaccines.

Childhood influenza immunization historically targeted children 6 months to 2 years of age, who experience severe illness and death at rates similar to other high-risk groups (such as adults >65 years of age), and children with chronic illnesses, including persistent asthma and other chronic respiratory diseases as well as cardiac, neurologic, metabolic, hepatic, renal, and immunologic disorders. However, routine influenza immunization for all children older than 6 months of age has been recommended since 2010. This recommendation is based on the following observations:

- Excess severe illness burden also occurs in children ages 2 to 5 years.

- Influenza causes preventable severe illness and death in previously healthy older children and young adults.
- Influenza immunization confers health benefits for all age groups.
- Children serve as a vehicle of transmission of influenza to unimmunized and unprotected individuals, including very young infants, immunocompromised individuals, and patients with contraindications to immunization.

Immunization of all health-care personnel and office staff is essential to protect vulnerable patients and to keep staff healthy and available to treat patients during community outbreaks. To ensure patient protection, compliance with annual influenza immunization is a condition of employment at many health-care facilities.

Influenza vaccine is administered annually to children ages 6 months and older, beginning as soon as vaccine becomes available. Although waning immunity late in the season is a consideration, missed opportunities to immunize and the challenging logistics of immunizing large numbers of patients in a narrow window of time support early immunization. Continuing immunization throughout the influenza season is also advised (Table 1).

Children ages 9 years and older require one dose of influenza vaccine annually. Younger children receiving either live or inactivated vaccine may require two doses separated by at least 28 days; recommendations vary from year to year. Currently, two doses are indicated if the child has not received two doses before the start of the current influenza season. The only exception to this rule is children who received one dose of influenza vaccine in the 2013-2014 season, who need only one dose in the 2014-2015 season. Because H1N1 has continued to circulate since the 2009-2010 season, children younger than 9 years also need two doses in the current season if at least one prior dose did not contain H1N1 antigen. H1N1 antigen has been included in all vaccines since 2010 and in monovalent H1N1 vaccine during the 2009-2010 season.

There are few true contraindications to influenza vaccine. Both inactivated and live attenuated influenza vaccines are contraindicated in patients with severe egg allergy. Patients with mild egg allergy without anaphylaxis may receive inactivated influenza vaccine, followed by 30 minutes of in-office observation.

A small increase in the risk of febrile seizures among children ages 6 months to 5 years has been observed in some seasons, particularly with simultaneous administration of pneumococcal conjugate vaccine. Although surveillance for an association between influenza vaccine and febrile seizures continues, current recommendations have not changed. However, one brand of influenza vaccine was more definitively associated with increased incidence of febrile seizures (Afluria, Merck and Co, Inc, Whitehouse Station, NJ) and is not routinely recommended for children younger than 9 years of age. (3)

Guillain-Barré syndrome (GBS) was associated with the 1976 swine influenza vaccine, but recent studies suggest at most a small increased risk of GBS following influenza immunization (approximately 1 additional case per 1 million doses). (4) Immunization of patients with a past history of GBS deserves careful consideration; the potential small increased risk of recurrent GBS must be balanced against the risk of influenza disease, particularly in individuals with other high-risk conditions.

Quadrivalent live attenuated influenza vaccine (LAIV4) has a similar safety profile and efficacy as compared to inactivated influenza vaccine, and is an option for healthy children 2 years of age and older. Adverse events following LAIV4 administration are uncommon and include minor respiratory and gastrointestinal symptoms such as

TABLE 1. **Influenza Vaccines Approved for Use in Children 6 Months to 17 Years of Age, 2014-2015 Season**

TRADE NAME	MANUFACTURER	FORMULATION	AGES INDICATED	ROUTE
Fluzone	Sanofi Pasteur	IIV3, IIV4, inactivated	≥6 mo	Intramuscular
FluMist	MedImmune	LAIV4, live attenuated	≥2 y (to 49 y)	Intranasal
Fluarix	GlaxoSmithKline	IIV3, IIV4, inactivated	≥3 y	Intramuscular
FluLaval	ID Biomedical Corporation of Quebec	IIV3, IIV4, inactivated	≥3 y	Intramuscular
Fluvirin	Novartis Vaccines and Diagnostics	IIV3, inactivated	≥4 y	Intramuscular
Afluria	CSL Limited	IIV4, inactivated	≥5 y*	Intramuscular

**American Academy of Pediatrics does not recommend routine use before age 9 years due to risk of febrile seizures.*

rhinorrhea, cough, abdominal pain, and fever. LAIV4 is contraindicated in pregnancy, egg allergy, and immunosuppression; in recipients of antiviral agents in the preceding 48 hours; and in children being treated with aspirin. Asthma and other underlying conditions that might be associated with a higher risk of influenza complications are precautions for LAIV4 due to the lack of safety evidence in affected patients. Children 2 to 4 years of age who have a history of wheezing in the last 12 months also should not receive LAIV4. Contacts of immunosuppressed patients may receive LAIV4, with the exception of caregivers of individuals with severe immunosuppression requiring a protected environment (eg, bone marrow transplant unit).

CONJUGATE VACCINES

Meningococcal Vaccines

Two quadrivalent conjugate vaccines (Menactra [MCV4-D], Sanofi Pasteur, Inc, Swiftwater, PA and Menveo [MCV4-CRM], Novartis Vaccines, Cambridge, MA) are currently available to protect against meningococcal strains A/C/Y and W-135. Nearly 75% of meningococcal infections in children 11 years and older involve these strains. (5) Two nonconjugate vaccines targeting serogroup B have recently been licensed for children and young adults ages 10–25 years (Bexsero, Novartis and Trumenba, Wyeth Pharmaceuticals Inc, Philadelphia, PA). Bexsero is administered in two doses one month apart; Trumenba requires three doses at 0, 2, and 6 months. While these vaccines have been used in outbreaks in New Jersey, California, Rhode Island, and Oregon, formal recommendations for use have not yet been published. Indications will likely include outbreak control and immunocompromise (complement deficiencies and asplenia). (6)

Conjugate meningococcal vaccines are preferred due to strong anamnestic responses to a subsequent booster dose, reduced nasopharyngeal carriage of meningococcus, and longer duration of clinical protection. (7) Quadrivalent meningococcal polysaccharide vaccine (Menomune [MPSV4], Sanofi) may be used when there is a contraindication to MCV4 (eg, severe allergy to diphtheria toxoid). Immunization is recommended at 11 to 12 years of age, with a booster dose at 16 to 18 years of age, at least 8 weeks after the first dose. Cases of meningococcal disease and deaths are significantly fewer with this two-dose regimen. Individuals receiving a first dose of vaccine at 16 years of age or older do not require a second dose, but unimmunized college freshman living in dormitories and those who received a single dose before age 16 years should receive one dose of vaccine. There has been a small increase in GBS clustered 14 days after administration of Menactra (but not Menveo). The risk of GBS is outweighed by the benefit of protection against meningococcal disease. Accordingly, a prior history of GBS was removed as a precaution to meningococcal vaccination in 2010. (6)

Routine immunization of children younger than 11 years of age is not recommended. Recommendations for meningococcal immunization for patients at increased risk vary with patient age and the specific indication for immunization (eg, potential exposure vs immune compromise). (7) In general, two doses of MCV4 separated by 8 to 12 weeks are recommended for children 2 years of age and older with immunodeficiency and adolescents 11 years of age or older with human immunodeficiency virus (HIV) infection. Only MCV4-D is approved for infants 2 to 9 months old at increased risk of meningococcal disease; either conjugate vaccine may be administered to infants and children older than 9 months. Children with functional or anatomic asplenia, including sickle cell disease, should not receive MCV4-D until after 2 years of age due to immune interference with 13-valent pneumococcal conjugate vaccine (PCV13). (7)

HibMenCY (MenHibrix, GlaxoSmithKline Biologicals, Rixensart, Belgium) is a bivalent meningococcal vaccine conjugated to *Haemophilus influenzae* b (Hib) that protects against strains C and Y. It is approved as a four-dose series for infants 6 weeks to 18 months of age at high risk due to functional or anatomic asplenia (including sickle cell disease), complement deficiencies, or exposure due to local outbreaks. When infants are immunized with HibMenCY, this vaccine should be used for all four doses, and other Hib-containing vaccines should not be given. For high-risk children 2 to 6 years of age, a booster dose with MCV4 is required 3 years after the primary series. Thereafter, and for children 7 years of age and older, a booster of MCV4 is required every 5 years. (7)

Pneumococcal Vaccines

Streptococcus pneumoniae is an important cause of respiratory tract disease (pneumonia, sinusitis, and otitis media), bacteremia, and meningitis. In 2010, PCV13 replaced the former 7-valent vaccine. The polysaccharide capsular antigens in PCV13 are individually conjugated to a diphtheria membrane protein. PCV13 is indicated for immunization of healthy children at 2, 4, 6, and 12 to 15 months of age as well as children and adults with immune compromise and other conditions that increase the risk for invasive pneumococcal disease. (8) Healthy children 15 to 59 months of age and children with underlying medical conditions younger than 72 months of age who were previously fully immunized with PCV7 should receive one dose of PCV13. Older children with immune compromise and other specific high-risk conditions for invasive disease (eg, cochlear implants,

cerebrospinal fluid leaks, and asplenia) should be immunized with one dose of PCV13 if not previously immunized.

A nonconjugate, 23-valent pneumococcal vaccine (PPS23) is also available for high-risk patients to protect against the 13 serotypes in PCV13 as well as 10 additional serotypes. PPS23 is poorly immunogenic in children younger than 24 months of age and is not used in this age group. PPS23 is indicated for patients 2 years of age and older with the following conditions:

- Chronic illnesses such as chronic lung disease (including asthma for those 19 years and older)
- Chronic cardiac, renal, and hepatic disease and diabetes
- Immunocompromising conditions such as sickle cell disease, HIV, and malignancy

For immunocompromised patients, PPS23 should be administered at least 8 weeks following a dose of PCV13. In childhood, only one additional dose of PPS23 is recommended, 5 years after the first dose (eg, for children with timely immunizations, PPS23 is administered at 2 years and 7 years). Pneumococcal vaccine administration is nuanced in patients with chronic disease and immunocompromise, and the reader is directed to the references for additional information. (8)(9)

Haemophilus Influenzae Type B Vaccines

Hib was a leading cause of bacteremia, meningitis, cellulitis, and epiglottitis in the prevaccine era. Hib capsular antigen is conjugated to either a tetanus or *Neisseria meningitidis*-derived carrier protein. Hib vaccine is given in three or four doses (determined by brand) at 2, 4, (6) and 12 to 15 months, either as a monovalent vaccine or in combination with diphtheria-tetanus-acellular pertussis-inactivated poliovirus. A single dose is sufficient for children ages 15 to 59 months of age who have delayed immunizations; a catch-up schedule is available for younger children with incomplete immunizations. Immunization may also be indicated for some older children with immune compromise. Adverse events following Hib vaccine are uncommon and largely limited to minor local reactions.

NONCONJUGATE INACTIVATED VACCINES

Hepatitis Vaccines

Hepatitis B infection is a common cause of acute and chronic liver disease, hepatocellular carcinoma, and death worldwide. Hepatitis B vaccine, composed of recombinant DNA-produced hepatitis B surface antigen (HBsAg), was the first vaccine to provide protection against cancer through prevention of infection with hepatitis B virus. Hepatitis B infection in newborns is rarely symptomatic but results in a chronic carrier state in more than 90% of infected infants. Prompt neonatal immunization is highly efficacious in preventing neonatal acquisition of hepatitis B. Therefore, for infants weighing at least 2 kg, hepatitis B vaccine is administered at birth, 1 to 2 months, and 6 months of age, with catch-up for unimmunized older children. Combination vaccines should not be used for the birth dose. The final dose should be provided no earlier than 24 weeks of age, at least 8 weeks following the second dose and at least 16 weeks following the first dose. For preterm infants weighing less than 2 kg, hepatitis B immunization is deferred until the infant reaches 1 month of age or hospital discharge (whichever comes first), unless the mother is HBsAg-positive or her status is unknown. In these situations, hepatitis B vaccine is given at birth, but the dose is not "counted" and is repeated when the infant reaches 1 to 2 months of age. (10)

Hepatitis B immune globulin (HBIG) is coadministered with hepatitis B vaccine within 12 hours of birth to infants born to hepatitis B-infected mothers and to preterm infants weighing less than 2 kg if the mother's results will not be available by 12 hours of age. For infants weighing more than 2 kg, HBIG administration may be deferred for up to 7 days or until the mother is determined to be HBsAg-positive. HBIG should be administered no later than 7 days after birth if the mother's results remain unavailable. Original maternal laboratory reports should be viewed directly; failure to recognize maternal hepatitis B infection and deferral of immunization outside of the perinatal period have been associated with preventable neonatal hepatitis B infection and rare deaths from fulminant neonatal hepatitis B. Infants born to HBsAg-positive mothers should be tested for hepatitis B surface antibody and HBsAg following the final dose of hepatitis B vaccine (typically at 9 to 12 months).

Hepatitis A infection is also an important cause of preventable liver disease. Two single-antigen inactivated hepatitis A vaccine (HAV) products are currently available for use in children: Havrix (GlaxoSmithKline) and VAQTA (Merck and Co, Inc). HAV is recommended for all children 12 months of age, with a booster dose 6 to 18 months later and catch-up for older children. Immunization is also recommended for household contacts of children adopted from countries with moderate-to-high rates of hepatitis A infection (currently applies to most international adoptees). Adverse events are uncommon. HAV and hepatitis A immune globulin are recommended for postexposure prophylaxis for unimmunized patients.

Diphtheria, Pertussis, and Tetanus Vaccines

Pertussis illness has a variety of presentations, including a nondescript upper respiratory tract infection, the classic

triphasic "100-day cough" syndrome, pneumonia, apnea (in young infants), seizures, and encephalopathy, with mortality occurring predominantly in infants. Tetanus is characterized by severe muscle spasms provoked by a neurotoxin, often progressing to respiratory failure. Diphtheria infection causes an acute membranous pharyngitis that may lead to airway obstruction. Although diphtheria and tetanus are now rare in the United States, pertussis infections remain endemic, with cyclic peaks occurring every 3 to 5 years.

Acellular pertussis vaccines have entirely replaced whole-cell pertussis vaccines. Although acellular pertussis vaccines contain varying pertussis antigens and quantities (Table 2), currently available products are believed to be equivalent in efficacy and safety. These products are associated with fewer adverse effects than whole-cell pertussis vaccines, but recent data also suggest a more rapid decline in immune protection following immunization with acellular pertussis vaccine. (11) Reported cases of pertussis have been increasing, particularly among children 10 years of age and older. Complete protection against pertussis is 98% at 1 year following the fifth dose of pertussis-containing vaccine, declining to 70% at 5 or more years following immunization.

Diphtheria-tetanus-acellular pertussis (DTaP) vaccine is administered in a five-dose series at 2, 4, and 6 months of age; at 15 to 18 months (at least 6 months following the third dose); and upon school entry (4-6 years). Only four doses are required if the fourth dose is given after 4 years of age. DTaP is often administered as a component of combination vaccines containing inactivated polio vaccine (IPV) and Hib or hepatitis B vaccine. DTaP and diphtheria-tetanus (DT) are not recommended for children 7 years or older.

Beginning in 2005, a single dose of Tdap replaced Td for adolescents 11 to 18 years of age. Since 2010, ACIP has also recommended a single dose of Tdap for unimmunized/underimmunized children 7 to 10 years of age due to lack of a licensed pertussis-containing vaccine for this age group. (12) Tdap is preferred for children 7 years of age and older because it is less reactogenic than DTaP (due to its reduced diphtheria and pertussis antigenic content) (Table 2). A single dose of Tdap is followed by up to three doses of Td for children who require additional doses to complete the routine series.

When indicated, Tdap may be administered with no minimum interval following the last dose of DTaP, DT, or Td. To achieve high antibody concentrations during pregnancy and passive protection of the newborn, mothers should be immunized with Tdap during each pregnancy, preferably during the third trimester. (13) With the exception of pregnancy, no booster doses of Tdap are recommended; subsequent doses should be administered as Td. Booster doses of Tdap may be recommended in the future as additional long-term safety and efficacy data become available.

A booster dose of a tetanus-containing vaccine is recommended for patients with clean wounds incurred 10 or more years since their last tetanus dose and for major or contaminated wounds seen 5 or more years since the last dose. Vaccine should also contain diphtheria and pertussis

TABLE 2. **Comparison of Selected Diphtheria and Pertussis-containing Vaccines**

TRADE NAME	DAPTACEL DTaP	INFANRIX DTaP	KINRIX DTaP-IPV	ADACEL Tdap	BOOSTRIX Tdap	PENTACEL DTaP-IPV-HIB	PEDIARIX DTaP- IPV-HEP B
Manufacturer	Sanofi Pasteur	GlaxoSmithKline	GlaxoSmithKline	Sanofi Pasteur	GlaxoSmithKline	Sanofi Pasteur	GlaxoSmithKline
Age approved	6 wk – 6 y	6 wk – 6 y	4 – 6 y	10 – 64 y	≥10 y	6 wk – 4 y	6 wk – 6 y
Tetanus toxoid	5 Lf	10 Lf	10 Lf	5 Lf	5 Lf	5 Lf	10 Lf
Diphtheria toxoid	15 Lf	25 Lf	25 Lf	2 Lf	2.5Lf	15 Lf	25 Lf
Pertussis Antigens:							
Filamentous hemagglutinin	5 μg	25 μg	25 μg	5 μg	8 μg	20 μg	25 μg
Inactivated pertussis toxin	10 μg	25 μg	25 μg	2.5 μg	8 μg	120 μg	25 μg
Pertactin	3 μg	8 μg	8 μg	3 μg	2.5 μg	3 μg	8 μg
Fimbriae Types 2 & 3	5 μg	-	-	5 μg	-	5 μg	-

Lf=limit of flocculation (units)

antigens, unless specifically contraindicated. Tetanus immune globulin is indicated only in isolated circumstances: massive or contaminated wounds in patients with unknown immunization status or who received fewer than three doses of tetanus-containing vaccine, persons with HIV or other severe immunocompromise regardless of immunization status, and potential umbilical cord contamination in an infant born to an unimmunized mother outside of a hospital. (14)

The most common reactions to DTaP are local and febrile. A temperature greater than 40.5°C (104.9°F), seizures, hypotonic-hyporesponsive episodes, and inconsolable crying are much less common after DTaP than was observed for whole-cell pertussis vaccine, but such occurrences represent precautions to subsequent doses of DTaP. These events are not associated with later epilepsy or other sequelae. Current evidence does not support a causal relationship between acellular pertussis vaccines and acute neurologic illness, but encephalopathy within 7 days of receipt of any pertussis-containing vaccine remains a contraindication to further pertussis immunization. Vaccination is typically deferred in young infants with evolving neurologic illnesses. If the indication for deferral persists beyond 1 year of age, immunization with DT is recommended up to the age of 7 years, after which time Td is advised. GBS and brachial neuritis are rare adverse events following tetanus toxoid administration but not after DTaP. GBS occurring within 6 weeks following Td or Tdap is a precaution to further doses. Generally, Td or Tdap are not administered in such situations, but individual circumstances should be considered.

Polio Vaccines

Polio vaccine has eliminated paralytic polio from the Western Hemisphere. Only IPV is available in the United States, due to the small but avoidable risk of vaccine-associated paralytic poliomyelitis caused by the live attenuated vaccine strain. The possibility of transmission of vaccine virus to unimmunized or immunocompromised household contacts is also eliminated by use of IPV.

IPV is administered in a four-dose series at 2, 4, 6 to 18 months, and 4 to 6 years of age. Only three doses are required if the third dose is given after 4 years of age, provided that at least 6 months have elapsed since the second dose. IPV is well tolerated and adverse events are rare. Adults are generally presumed to be immune to polio and are only immunized if they are at increased risk of infection (eg, travelers and those with occupational exposures).

Human Papillomavirus Vaccines

Approximately 40 types of human papillomaviruses (HPVs) infect humans, predominantly through sexual contact. The spectrum of illness ranges from asymptomatic infection to genital warts, genital cancers (particularly cervical cancer), anal and head-and-neck cancers, and rarely, laryngeal papillomatosis (via vertical transmission during vaginal delivery). Two licensed vaccines (Gardasil, Merck and Co, Inc, and Cervarix, GlaxoSmithKline) provide protection against HPV types 16 and 18, which together cause approximately 70% of cervical cancers. Gardasil also provides protection against types 6 and 11, which cause 90% of genital warts. (15) Immunization is recommended routinely for both boys and girls at age 11 to 12 years, ideally before initiation of sexual activity. (16) A newly licensed 9-valent HPV vaccine (Gardasil 9, Merck and Co, Inc) targets the four HPV types in Gardasil, as well as types 31, 33, 45, 52, and 58; these additions extend coverage to approximately 90% of cervical cancer cases. (17) Recommendations for series completion and reimmunization for recipients of Gardasil have not yet been released. HPV immunization can be initiated as early as age 9 years and up to 26 years for those not previously immunized. For all three formulations, three doses are administered, with subsequent doses given 2 months and 6 months following the first dose. Because Gardasil contains *Saccharomyces cerevisiae*, it is contraindicated for those with allergy to baker's yeast. Data on vaccination during pregnancy are limited and, therefore, immunization during pregnancy is not recommended. Observation of patients for 15 minutes following vaccination is advised due to an association with syncope. Syncope is not a contraindication to future administration of any vaccine.

LIVE VACCINES

Measles-Mumps-Rubella Vaccines and Varicella Vaccine

Measles, mumps, and rubella have been largely eliminated from the United States. However, a record-breaking resurgence of measles occurred in 2014, with most case reports related to international travel and importation of disease by unimmunized individuals, followed by spread in unimmunized/underimmunized communities. (18) Varicella infection (chickenpox), varicella meningoencephalitis, and secondary complications of cellulitis and pneumonia have also declined. Because approximately 5% to 10% of individuals fail to seroconvert following immunization, two doses of MMR and varicella are given in childhood (at 12 months and 4 to 6 years of age). However, cases of measles, mumps, and varicella do occur, even in patients who have received two doses of vaccine. (18)(19) The minimum interval between doses is 28 days for MMR and varicella vaccine given at 13 years of age and older and 3 months for measles-

TABLE 3. Additional Vaccines Indicated for Certain International Travelers

VACCINE	TYPE	AGE INDICATED	SCHEDULE	BOOSTER[1]
Japanese encephalitis	Inactivated	≥2 mo	2 doses 28 d apart	Duration of protection unknown, possibly boost after 1–2 y in adults
Measles[2]	Live attenuated	≥12 mo 6 – <12 mo	2 doses at least 28 d apart Single dose	Not needed After 12 mo of age: 2 doses at least 28 d apart
Meningococcal	Inactivated	2 – 18 mo 7 – 23 mo 9 – 23 mo ≥24 mo	2, 4, 6, and 14–15 mo 2 doses 3 mo apart (MCV4-CRM[3]) 2 doses 3 mo apart, (MCV4-CRM or MCV4-D[4]) 1 dose MCV4	1 dose in 3 y; then every 5 y thereafter As above As above Every 5 y
Polio[5]	Inactivated	≥6 wk	If needed, accelerated schedule, doses #2 and #3 in ≥4-wk intervals, #4 ≥6 mo	One dose after 4 y of age, one dose <12 mo before leaving polio-infected or polio-exporting country
Rabies	Inactivated	All	Day 0, 7, 21, or 28	Depends on risk, yes if exposed
Typhoid fever	Live attenuated Inactivated	≥6 y ≥2 y	Day 0, 2, 4, 6 1 dose	Every 5 y Every 2 y
Yellow Fever	Live attenuated	≥9 mo	1 dose	Every 10 y

[1]*If risk continues.*
[2]*Given as MMR in United States; monovalent measles vaccine may be available in other countries.*
[3]*MCV4-CRM:Quadrivalent meningococcal conjugate vaccine (Menveo)*
[4]*MCV4:Quadrivalent meningococcal vaccine (Menactra)*
[5]*Series may be continued in other countries if needed as inactivated polio vaccine or live attenuated oral polio vaccine.*
Wallace GS, Seward JF, Pallanasch MA. Interim CDC guidance for polio vaccination for travel to and from countries affected by wild poliovirus. Morb Mortal Wkly Rep. *2014;63(27):591-594.*[25]

mumps-rubella-varicella (MMRV) (ProQuad, Merck and Co, Inc), and varicella vaccine given to children younger than 13 years of age. Immunization may be accomplished by administering the trivalent MMR and monovalent varicella vaccines separately (but simultaneously) or MMRV to children younger than 13 years. Because MMRV is associated with a higher risk of febrile seizures than MMR, children with a personal or family history of seizure should generally be immunized with MMR and varicella separately for the first dose. (20) Varicella vaccine is contraindicated in individuals with neomycin or gelatin allergy. Egg allergy is not a contraindication because MMR is derived from tissue culture.

During outbreaks, age-appropriate receipt of recommended vaccine should be assured. Postexposure prophylaxis may be efficacious in reducing measles and varicella infection (but not rubella or mumps) if administered within 72 hours of exposure. Potentially exposed children 13 months and older may be given a second dose of vaccine at least 28 days following receipt of the first dose. MMR can be administered to infants at least 6 months of age who are at increased risk of exposure, including international travelers. Because the immune response may be reduced in this age group, a dose of MMR administered before 12 months of age is not counted as one of the two required doses. The role of a third dose for outbreak control is an area of investigation and is not routinely recommended at present.

MMR and varicella vaccines are not recommended in pregnancy, and pregnancy should be avoided for 28 days following receipt of these vaccines. (20) If either vaccine is inadvertently given, termination of the pregnancy is not specifically advised, but the mother should be counseled that there is a theoretical risk of harm to the fetus. Prior history of idiopathic thrombocytopenic purpura is a precaution to MMR vaccine because affected individuals may be at increased risk for recurrence following immunization. As live attenuated vaccines, MMR and varicella vaccines are not

TABLE 4. Resources for International Travel

CDC Travelers Health Website: www.cdc.gov/travel/
CDC : 1-800-CDC-INFO
CDC Yellow Book: Health Information for International Travel, 2014 (updated every 2 years)
World Health Organization: www.who.int/ith/

recommended for use in immunocompromised individuals, except those with HIV who do not have severe immunosuppression. Measles inclusion body encephalitis has been described rarely in individuals with immunodeficiency. (20) Zoster (shingles) may occur following varicella vaccine administration, but the risk is greatly reduced compared to zoster following wild-type chickenpox, and symptoms are substantially milder.

Varicella immune globulin should be administered as soon as possible (up to 10 days following exposure) to high-risk individuals exposed to varicella virus. High-risk individuals include nonimmune pregnant women, neonates born to mothers with varicella infection from 5 days prior to 2 days after delivery, all hospitalized preterm infants born before 28 weeks' gestation or whose birthweight is 1,000 g or less, and hospitalized preterm infants 28 weeks' gestation or older born to nonimmune mothers. (21)

Rotavirus Vaccines

Rotavirus vaccine is indicated for the prevention of acute diarrheal disease due to rotavirus infection in healthy infants. The vaccine is administered orally on a two-dose (Rotarix, GlaxoSmithKline) or three-dose schedule (Rotateq, Merck and Co, Inc) at 2, 4, (and 6) months of age. The first dose should not be administered after 14 weeks and 6 days of age, and the final dose should not be administered after 8 months of age. Another rotavirus vaccine, RotaShield (Wyeth Laboratories, Inc, Marietta, PA), was withdrawn from the market in 1999 due to an association with intussusception. Reports of intussusception with current rotavirus vaccine cluster 3 to 7 days following the first dose only. (22) The increased risk of intussusception is estimated at 1 to 5 per 100,000 doses. In contrast, rotavirus vaccine prevents 40,000 hospitalizations in the United States annually. Rotavirus vaccine is contraindicated in patients with a history of intussusception due to increased risk of recurrence in this group (23) and in patients with severe combined immunodeficiency. (24)

VACCINES FOR INTERNATIONAL TRAVELERS

Travelers should allow at least 8 weeks before international travel to accomplish appropriate health planning and allow sufficient time for development of immune protection from vaccines. (26) International travelers should be up to date with all routine immunizations. Additional vaccines (Table 3) or immune globulin may be indicated under special circumstances. Yellow fever vaccine is only available at designated clinics, and cholera and tickborne encephalitis vaccines are currently not available in the United States. Child age, duration of travel, season, presence of infectious disease outbreaks, and contact with local populations (eg, home stay with relatives vs resort accommodations) may influence immunization decisions. The CDC provides excellent, regularly updated resources to assist with immunization and other health considerations for travel planning (Table 4). Consultation with an infectious disease specialist or travel clinic may also be of benefit, particularly for travel to higher-risk areas such as developing countries. In general, written documentation of vaccines administered outside of the United States may be considered valid.

Summary

- The childhood immunization schedule is complex and nuanced. Although serious adverse reactions to immunizations are uncommon, clinicians must be well-versed in these reactions as well as the contraindications and precautions to each vaccine.
- Conjugate vaccine technology links polysaccharide antigens to carrier proteins, triggering T-cell-dependent immunity to polysaccharides, thereby strengthening immune memory.
- On the basis of some research evidence and consensus, live vaccines are generally contraindicated in immunocompromised patients and in pregnancy. (8)(20) Most live vaccines can be administered to household contacts of immunocompromised patients. (8)(20)
- On the basis of some research and consensus, modified administration of meningococcal, pneumococcal, and less commonly, other vaccines may be indicated to protect immunocompromised patients. (2)(3)(7)(8)(20)
- On the basis of disease epidemiology and consensus, international travelers should be up-to-date with all routine immunizations; depending on destination, additional vaccines or immune globulin may be required. (26)

RESOURCES FOR HEALTH-CARE PROFESSIONALS AND FAMILIES:

American Academy of Pediatrics: www.healthychildren.org
Centers for Disease Control and Prevention: www.cdc.gov/vaccines
Immunization Action Coalition: www.immunize.org

References for this article are at http://pedsinreview.aappublications.org/content/36/6/249.full.

Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger

UNITED STATES 2021

Vaccines in the Child and Adolescent Immunization Schedule*

Vaccines	Abbreviations	Trade names
Diphtheria, tetanus, and acellular pertussis vaccine	**DTaP**	Daptacel® Infanrix®
Diphtheria, tetanus vaccine	**DT**	No trade name
Haemophilus influenzae type b vaccine	**Hib (PRP-T)** **Hib (PRP-OMP)**	ActHIB® Hiberix® PedvaxHIB®
Hepatitis A vaccine	**HepA**	Havrix® Vaqta®
Hepatitis B vaccine	**HepB**	Engerix-B® Recombivax HB®
Human papillomavirus vaccine	**HPV**	Gardasil 9®
Influenza vaccine (inactivated)	**IIV**	Multiple
Influenza vaccine (live, attenuated)	**LAIV4**	FluMist® Quadrivalent
Measles, mumps, and rubella vaccine	**MMR**	M-M-R II®
Meningococcal serogroups A, C, W, Y vaccine	**MenACWY-D**	Menactra®
	MenACWY-CRM	Menveo®
	MenACWY-TT	MenQuadfi®
Meningococcal serogroup B vaccine	**MenB-4C**	Bexsero®
	MenB-FHbp	Trumenba®
Pneumococcal 13-valent conjugate vaccine	**PCV13**	Prevnar 13®
Pneumococcal 23-valent polysaccharide vaccine	**PPSV23**	Pneumovax 23®
Poliovirus vaccine (inactivated)	**IPV**	IPOL®
Rotavirus vaccine	**RV1** **RV5**	Rotarix® RotaTeq®
Tetanus, diphtheria, and acellular pertussis vaccine	**Tdap**	Adacel® Boostrix®
Tetanus and diphtheria vaccine	**Td**	Tenivac® Tdvax™
Varicella vaccine	**VAR**	Varivax®
Combination vaccines *(use combination vaccines instead of separate injections when appropriate)*		
DTaP, hepatitis B, and inactivated poliovirus vaccine	**DTaP-HepB-IPV**	Pediarix®
DTaP, inactivated poliovirus, and *Haemophilus influenzae* type b vaccine	**DTaP-IPV/Hib**	Pentacel®
DTaP and inactivated poliovirus vaccine	**DTaP-IPV**	Kinrix® Quadracel®
DTaP, inactivated poliovirus, *Haemophilus influenzae* type b, and hepatitis B vaccine	**DTaP-IPV-Hib-HepB**	Vaxelis®
Measles, mumps, rubella, and varicella vaccine	**MMRV**	ProQuad®

*Administer recommended vaccines if immunization history is incomplete or unknown. Do not restart or add doses to vaccine series for extended intervals between doses. When a vaccine is not administered at the recommended age, administer at a subsequent visit. The use of trade names is for identification purposes only and does not imply endorsement by the ACIP or CDC.

How to use the child/adolescent immunization schedule

1 Determine recommended vaccine by age **(Table 1)**

2 Determine recommended interval for catch-up vaccination **(Table 2)**

3 Assess need for additional recommended vaccines by medical condition and other indications **(Table 3)**

4 Review vaccine types, frequencies, intervals, and considerations for special situations **(Notes)**

Recommended by the Advisory Committee on Immunization Practices (www.cdc.gov/vaccines/acip) and approved by the Centers for Disease Control and Prevention (www.cdc.gov), American Academy of Pediatrics (www.aap.org), American Academy of Family Physicians (www.aafp.org), American College of Obstetricians and Gynecologists (www.acog.org), American College of Nurse-Midwives (www.midwife.org), American Academy of Physician Assistants (www.aapa.org), and National Association of Pediatric Nurse Practitioners (www.napnap.org).

Report

- Suspected cases of reportable vaccine-preventable diseases or outbreaks to your state or local health department
- Clinically significant adverse events to the Vaccine Adverse Event Reporting System (VAERS) at www.vaers.hhs.gov or 800-822-7967

Download the CDC Vaccine Schedules App for providers at www.cdc.gov/vaccines/schedules/hcp/schedule-app.html.

Helpful information

- Complete ACIP recommendations: www.cdc.gov/vaccines/hcp/acip-recs/index.html
- *General Best Practice Guidelines for Immunization*: www.cdc.gov/vaccines/hcp/acip-recs/general-recs/index.html
- Outbreak information (including case identification and outbreak response), see Manual for the Surveillance of Vaccine-Preventable Diseases: www.cdc.gov/vaccines/pubs/surv-manual
- ACIP Shared Clinical Decision-Making Recommendations www.cdc.gov/vaccines/acip/acip-scdm-faqs.html

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

Table 1 Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2021

These recommendations must be read with the notes that follow. For those who fall behind or start late, provide catch-up vaccination at the earliest opportunity as indicated by the green bars. To determine minimum intervals between doses, see the catch-up schedule (Table 2). School entry and adolescent vaccine age groups are shaded in gray.

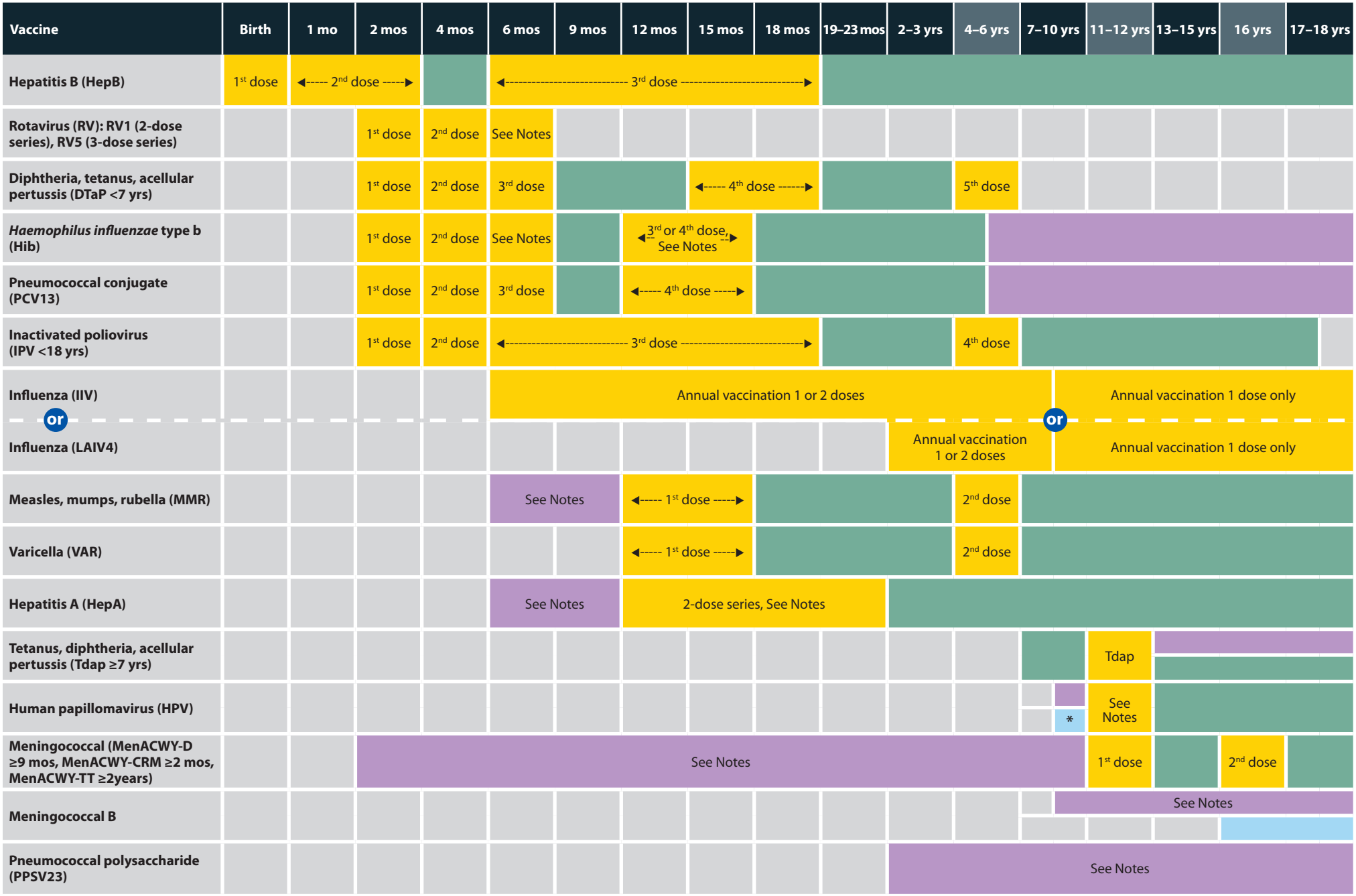

Table 2 Recommended Catch-up Immunization Schedule for Children and Adolescents Who Start Late or Who Are More than 1 month Behind, United States, 2021

The table below provides catch-up schedules and minimum intervals between doses for children whose vaccinations have been delayed. A vaccine series does not need to be restarted, regardless of the time that has elapsed between doses. Use the section appropriate for the child's age. **Always use this table in conjunction with Table 1 and the notes that follow.**

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
Children age 4 months through 6 years					
Hepatitis B	Birth	**4 weeks**	**8 weeks *and* at least 16 weeks after first dose.** Minimum age for the final dose is 24 weeks.		
Rotavirus	6 weeks Maximum age for first dose is 14 weeks, 6 days.	**4 weeks**	**4 weeks** Maximum age for final dose is 8 months, 0 days.		
Diphtheria, tetanus, and acellular pertussis	6 weeks	**4 weeks**	**4 weeks**	**6 months**	**6 months**
Haemophilus influenzae type b	6 weeks	**No further doses needed** if first dose was administered at age 15 months or older. **4 weeks** if first dose was administered before the 1st birthday. **8 weeks (as final dose)** if first dose was administered at age 12 through 14 months.	**No further doses needed** if previous dose was administered at age 15 months or older. **4 weeks** if current age is younger than 12 months ***and*** first dose was administered at younger than age 7 months ***and*** at least 1 previous dose was PRP-T (ActHib, Pentacel, Hiberix) or unknown. **8 weeks *and* age 12 through 59 months (as final dose)** if current age is younger than 12 months ***and*** first dose was administered at age 7 through 11 months; OR if current age is 12 through 59 months ***and*** first dose was administered before the 1st birthday ***and*** second dose was administered at younger than 15 months; OR if both doses were PRP-OMP (PedvaxHIB, Comvax) ***and*** were administered before the 1st birthday.	**8 weeks (as final dose)** This dose only necessary for children age 12 through 59 months who received 3 doses before the 1st birthday.	
Pneumococcal conjugate	6 weeks	**No further doses needed** for healthy children if first dose was administered at age 24 months or older. **4 weeks** if first dose was administered before the 1st birthday. **8 weeks (as final dose for healthy children)** if first dose was administered at the 1st birthday or after.	**No further doses needed** for healthy children if previous dose was administered at age 24 months or older. **4 weeks** if current age is younger than 12 months and previous dose was administered at <7 months old. **8 weeks (as final dose for healthy children)** if previous dose was administered between 7–11 months (wait until at least 12 months old); OR if current age is 12 months or older and at least 1 dose was administered before age 12 months.	**8 weeks (as final dose)** This dose only necessary for children age 12 through 59 months who received 3 doses before age 12 months or for children at high risk who received 3 doses at any age.	
Inactivated poliovirus	6 weeks	**4 weeks**	**4 weeks** if current age is <4 years. **6 months (as final dose)** if current age is 4 years or older.	**6 months** (minimum age 4 years for final dose).	
Measles, mumps, rubella	12 months	**4 weeks**			
Varicella	12 months	**3 months**			
Hepatitis A	12 months	**6 months**			
Meningococcal ACWY	2 months MenACWY-CRM 9 months MenACWY-D 2 years MenACWY-TT	**8 weeks**	See Notes	See Notes	
Children and adolescents age 7 through 18 years					
Meningococcal ACWY	Not applicable (N/A)	**8 weeks**			
Tetanus, diphtheria; tetanus, diphtheria, and acellular pertussis	7 years	**4 weeks**	**4 weeks** if first dose of DTaP/DT was administered before the 1st birthday. **6 months (as final dose)** if first dose of DTaP/DT or Tdap/Td was administered at or after the 1st birthday.	**6 months** if first dose of DTaP/DT was administered before the 1st birthday.	
Human papillomavirus	9 years	**Routine dosing intervals are recommended.**			
Hepatitis A	N/A	**6 months**			
Hepatitis B	N/A	**4 weeks**	**8 weeks *and* at least 16 weeks after first dose.**		
Inactivated poliovirus	N/A	**4 weeks**	**6 months** A fourth dose is not necessary if the third dose was administered at age 4 years or older and at least 6 months after the previous dose.	A fourth dose of IPV is indicated if all previous doses were administered at <4 years or if the third dose was administered <6 months after the second dose.	
Measles, mumps, rubella	N/A	**4 weeks**			
Varicella	N/A	**3 months** if younger than age 13 years. **4 weeks** if age 13 years or older.			

Table 3 Recommended Child and Adolescent Immunization Schedule by Medical Indication, United States, 2021

Always use this table in conjunction with Table 1 and the notes that follow.

VACCINE	INDICATION									
	Pregnancy	Immunocompromised status (excluding HIV infection)	HIV infection CD4+ count[1]		Kidney failure, end-stage renal disease, or on hemodialysis	Heart disease or chronic lung disease	CSF leak or cochlear implant	Asplenia or persistent complement component deficiencies	Chronic liver disease	Diabetes
			<15% and total CD4 cell count of <200/mm³	≥15% and total CD4 cell count of ≥200/mm³						
Hepatitis B										
Rotavirus		SCID[2]								
Diphtheria, tetanus, and acellular pertussis (DTaP)										
Haemophilus influenzae type b										
Pneumococcal conjugate										
Inactivated poliovirus										
Influenza (IIV)										
or										
Influenza (LAIV4)						Asthma, wheezing: 2–4yrs[3]				
Measles, mumps, rubella	*									
Varicella	*									
Hepatitis A										
Tetanus, diphtheria, and acellular pertussis (Tdap)										
Human papillomavirus	*									
Meningococcal ACWY										
Meningococcal B										
Pneumococcal polysaccharide										

Vaccination according to the routine schedule recommended

Recommended for persons with an additional risk factor for which the vaccine would be indicated

Vaccination is recommended, and additional doses may be necessary based on medical condition. See Notes.

Not recommended/ contraindicated—vaccine should not be administered.

*Vaccinate after pregnancy.

Precaution—vaccine might be indicated if benefit of protection outweighs risk of adverse reaction

No recommendation/not applicable

1 For additional information regarding HIV laboratory parameters and use of live vaccines, see the *General Best Practice Guidelines for Immunization*, "Altered Immunocompetence," at www.cdc.gov/vaccines/hcp/acip-recs/general-recs/immunocompetence.html and Table 4-1 (footnote D) at www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html.

2 Severe Combined Immunodeficiency

3 LAIV4 contraindicated for children 2–4 years of age with asthma or wheezing during the preceding 12 months

Notes

Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2021

For vaccination recommendations for persons ages 19 years or older, see the Recommended Adult Immunization Schedule, 2021.

Additional information

COVID-19 Vaccination

ACIP recommends use of COVID-19 vaccines within the scope of the Emergency Use Authorization or Biologics License Application for the particular vaccine. Interim ACIP recommendations for the use of COVID-19 vaccines can be found at www.cdc.gov/vaccines/hcp/acip-recs/.

- Consult relevant ACIP statements for detailed recommendations at www.cdc.gov/vaccines/hcp/acip-recs/index.html.
- For information on contraindications and precautions for the use of a vaccine, consult the *General Best Practice Guidelines for Immunization* at www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html and relevant ACIP statements at www.cdc.gov/vaccines/hcp/acip-recs/index.html.
- For calculating intervals between doses, 4 weeks = 28 days. Intervals of ≥4 months are determined by calendar months.
- Within a number range (e.g., 12–18), a dash (–) should be read as "through."
- Vaccine doses administered ≤4 days before the minimum age or interval are considered valid. Doses of any vaccine administered ≥5 days earlier than the minimum age or minimum interval should not be counted as valid and should be repeated as age appropriate. **The repeat dose should be spaced after the invalid dose by the recommended minimum interval.** For further details, see Table 3-1, Recommended and minimum ages and intervals between vaccine doses, in *General Best Practice Guidelines for Immunization* at www.cdc.gov/vaccines/hcp/acip-recs/general-recs/timing.html.
- Information on travel vaccination requirements and recommendations is available at www.cdc.gov/travel/.
- For vaccination of persons with immunodeficiencies, see Table 8-1, Vaccination of persons with primary and secondary immunodeficiencies, in *General Best Practice Guidelines for Immunization* at www.cdc.gov/vaccines/hcp/acip-recs/general-recs/immunocompetence.html, and Immunization in Special Clinical Circumstances (In: Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. *Red Book: 2018 Report of the Committee on Infectious Diseases*. 31st ed. Itasca, IL: American Academy of Pediatrics; 2018:67–111).
- For information about vaccination in the setting of a vaccine-preventable disease outbreak, contact your state or local health department.
- The National Vaccine Injury Compensation Program (VICP) is a no-fault alternative to the traditional legal system for resolving vaccine injury claims. All routine child and adolescent vaccines are covered by VICP except for pneumococcal polysaccharide vaccine (PPSV23). For more information, see www.hrsa.gov/vaccinecompensation/index.html.

Diphtheria, tetanus, and pertussis (DTaP) vaccination (minimum age: 6 weeks [4 years for Kinrix or Quadracel])

Routine vaccination

- 5-dose series at 2, 4, 6, 15–18 months, 4–6 years
  - **Prospectively:** Dose 4 may be administered as early as age 12 months if at least 6 months have elapsed since dose 3.
  - **Retrospectively:** A 4th dose that was inadvertently administered as early as age 12 months may be counted if at least 4 months have elapsed since dose 3.

Catch-up vaccination

- Dose 5 is not necessary if dose 4 was administered at age 4 years or older and at least 6 months after dose 3.
- For other catch-up guidance, see Table 2.

Special situations

- Wound management in children less than age 7 years with history of 3 or more doses of tetanus-toxoid-containing vaccine: For all wounds except clean and minor wounds, administer DTaP if more than 5 years since last dose of tetanus-toxoid-containing vaccine. For detailed information, see www.cdc.gov/mmwr/volumes/67/rr/rr6702a1.htm.

Haemophilus influenzae type b vaccination (minimum age: 6 weeks)

Routine vaccination

- **ActHIB, Hiberix, or Pentacel:** 4-dose series at 2, 4, 6, 12–15 months
- **PedvaxHIB:** 3-dose series at 2, 4, 12–15 months

Catch-up vaccination

- **Dose 1 at age 7–11 months:** Administer dose 2 at least 4 weeks later and dose 3 (final dose) at age 12–15 months or 8 weeks after dose 2 (whichever is later).
- **Dose 1 at age 12–14 months:** Administer dose 2 (final dose) at least 8 weeks after dose 1.
- **Dose 1 before age 12 months and dose 2 before age 15 months:** Administer dose 3 (final dose) 8 weeks after dose 2.
- **2 doses of PedvaxHIB before age 12 months:** Administer dose 3 (final dose) at 12–59 months and at least 8 weeks after dose 2.
- **1 dose administered at age 15 months or older:** No further doses needed
- **Unvaccinated at age 15–59 months:** Administer 1 dose.
- **Previously unvaccinated children age 60 months or older who are not considered high risk:** Do not require catch-up vaccination
- For other catch-up guidance, see Table 2.

Special situations

- **Chemotherapy or radiation treatment:**
  12–59 months
  - Unvaccinated or only 1 dose before age 12 months: 2 doses, 8 weeks apart
  - 2 or more doses before age 12 months: 1 dose at least 8 weeks after previous dose

  Doses administered within 14 days of starting therapy or during therapy should be repeated at least 3 months after therapy completion.
- **Hematopoietic stem cell transplant (HSCT):**
  - 3-dose series 4 weeks apart starting 6 to 12 months after successful transplant, regardless of Hib vaccination history
- **Anatomic or functional asplenia (including sickle cell disease):**
  12–59 months
  - Unvaccinated or only 1 dose before age 12 months: 2 doses, 8 weeks apart
  - 2 or more doses before age 12 months: 1 dose at least 8 weeks after previous dose

  Unvaccinated persons age 5 years or older*
  - 1 dose
- **Elective splenectomy:**
  Unvaccinated persons age 15 months or older*
  - 1 dose (preferably at least 14 days before procedure)
- **HIV infection:**
  12–59 months
  - Unvaccinated or only 1 dose before age 12 months: 2 doses, 8 weeks apart
  - 2 or more doses before age 12 months: 1 dose at least 8 weeks after previous dose

  Unvaccinated persons age 5–18 years*
  - 1 dose
- **Immunoglobulin deficiency, early component complement deficiency:**
  12–59 months
  - Unvaccinated or only 1 dose before age 12 months: 2 doses, 8 weeks apart
  - 2 or more doses before age 12 months: 1 dose at least 8 weeks after previous dose

**Unvaccinated* = Less than routine series (through age 14 months) OR no doses (age 15 months or older)

Notes

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Hepatitis A vaccination
(minimum age: 12 months for routine vaccination)

Routine vaccination
- 2-dose series (minimum interval: 6 months) beginning at age 12 months

Catch-up vaccination
- Unvaccinated persons through age 18 years should complete a 2-dose series (minimum interval: 6 months).
- Persons who previously received 1 dose at age 12 months or older should receive dose 2 at least 6 months after dose 1.
- Adolescents age 18 years or older may receive the combined HepA and HepB vaccine, **Twinrix®**, as a 3-dose series (0, 1, and 6 months) or 4-dose series (3 doses at 0, 7, and 21–30 days, followed by a booster dose at 12 months).

International travel
- Persons traveling to or working in countries with high or intermediate endemic hepatitis A (www.cdc.gov/travel/):
  - **Infants age 6–11 months**: 1 dose before departure; revaccinate with 2 doses, separated by at least 6 months, between age 12–23 months.
  - **Unvaccinated age 12 months or older**: Administer dose 1 as soon as travel is considered.

Hepatitis B vaccination
(minimum age: birth)

Birth dose (monovalent HepB vaccine only)
- **Mother is HBsAg-negative:** 1 dose within 24 hours of birth for **all** medically stable infants ≥2,000 grams. Infants <2,000 grams: Administer 1 dose at chronological age 1 month or hospital discharge (whichever is earlier and even if weight is still <2,000 grams).
- **Mother is HBsAg-positive:**
  - Administer **HepB vaccine** and **hepatitis B immune globulin (HBIG)** (in separate limbs) within 12 hours of birth, regardless of birth weight. For infants <2,000 grams, administer 3 additional doses of vaccine (total of 4 doses) beginning at age 1 month.
  - Test for HBsAg and anti-HBs at age 9–12 months. If HepB series is delayed, test 1–2 months after final dose.
- **Mother's HBsAg status is unknown:**
  - Administer **HepB vaccine** within 12 hours of birth, regardless of birth weight.
  - For infants <2,000 grams, administer **HBIG** in addition to HepB vaccine (in separate limbs) within 12 hours of birth. Administer 3 additional doses of vaccine (total of 4 doses) beginning at age 1 month.
  - Determine mother's HBsAg status as soon as possible. If mother is HBsAg-positive, administer **HBIG** to infants ≥2,000 grams as soon as possible, but no later than 7 days of age.

Routine series
- 3-dose series at 0, 1–2, 6–18 months (use monovalent HepB vaccine for doses administered before age 6 weeks)
- Infants who did not receive a birth dose should begin the series as soon as feasible (see Table 2).
- Administration of **4 doses** is permitted when a combination vaccine containing HepB is used after the birth dose.
- **Minimum age** for the final (3rd or 4th) dose: 24 weeks
- **Minimum intervals:** dose 1 to dose 2: 4 weeks / dose 2 to dose 3: 8 weeks / dose 1 to dose 3: 16 weeks (when 4 doses are administered, substitute "dose 4" for "dose 3" in these calculations)

Catch-up vaccination
- Unvaccinated persons should complete a 3-dose series at 0, 1–2, 6 months.
- Adolescents age 11–15 years may use an alternative 2-dose schedule with at least 4 months between doses (adult formulation **Recombivax HB** only).
- Adolescents age 18 years or older may receive a 2-dose series of HepB **(Heplisav-B®)** at least 4 weeks apart.
- Adolescents age 18 years or older may receive the combined HepA and HepB vaccine, **Twinrix**, as a 3-dose series (0, 1, and 6 months) or 4-dose series (3 doses at 0, 7, and 21–30 days, followed by a booster dose at 12 months).
- For other catch-up guidance, see Table 2.

Special situations
- Revaccination is not generally recommended for persons with a normal immune status who were vaccinated as infants, children, adolescents, or adults.
- **Revaccination** may be recommended for certain populations, including:
  - **Infants born to HBsAg-positive mothers**
  - **Hemodialysis patients**
  - **Other immunocompromised persons**
- For detailed revaccination recommendations, see www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/hepb.html.

Human papillomavirus vaccination
(minimum age: 9 years)

Routine and catch-up vaccination
- HPV vaccination routinely recommended at **age 11–12 years (can start at age 9 years)** and catch-up HPV vaccination recommended for all persons through age 18 years if not adequately vaccinated
- 2- or 3-dose series depending on age at initial vaccination:
  - **Age 9–14 years at initial vaccination**: 2-dose series at 0, 6–12 months (minimum interval: 5 months; repeat dose if administered too soon)
  - **Age 15 years or older at initial vaccination**: 3-dose series at 0, 1–2 months, 6 months (minimum intervals: dose 1 to dose 2: 4 weeks / dose 2 to dose 3: 12 weeks / dose 1 to dose 3: 5 months; repeat dose if administered too soon)
- **Interrupted schedules:** If vaccination schedule is interrupted, the series does not need to be restarted.
- No additional dose recommended after completing series with recommended dosing intervals using any HPV vaccine.

Special situations
- **Immunocompromising conditions, including HIV infection:** 3-dose series as above
- **History of sexual abuse or assault:** Start at age 9 years.
- **Pregnancy:** HPV vaccination not recommended until after pregnancy; no intervention needed if vaccinated while pregnant; pregnancy testing not needed before vaccination

Influenza vaccination
(minimum age: 6 months [IIV], 2 years [LAIV4], 18 years [recombinant influenza vaccine, RIV4])

Routine vaccination
- Use any influenza vaccine appropriate for age and health status annually:
  - 2 doses, separated by at least 4 weeks, for **children age 6 months–8 years** who have received fewer than 2 influenza vaccine doses before July 1, 2020, or whose influenza vaccination history is unknown (administer dose 2 even if the child turns 9 between receipt of dose 1 and dose 2)
  - 1 dose for **children age 6 months–8 years** who have received at least 2 influenza vaccine doses before July 1, 2020
  - 1 dose for **all persons age 9 years or older**
- For the 2021–22 season, see the 2021–22 ACIP influenza vaccine recommendations.

Special situations
- **Egg allergy, hives only**: Any influenza vaccine appropriate for age and health status annually
- **Egg allergy with symptoms other than hives** (e.g., angioedema, respiratory distress, need for emergency medical services or epinephrine): Any influenza vaccine appropriate for age and health status annually. If using an influenza vaccine other than Flublok or Flucelvax, administer in medical setting under supervision of health care provider who can recognize and manage severe allergic reactions.
- Severe allergic reactions to vaccines can occur even in the absence of a history of previous allergic reaction. All vaccination providers should be familiar with the office emergency plan and certified in cardiopulmonary resuscitation.
- A previous severe allergic reaction to influenza vaccine is a contraindication to future receipt of any influenza vaccine.
- **LAIV4 should not be used** in persons with the following conditions or situations:
  - History of severe allergic reaction to a previous dose of any influenza vaccine or to any vaccine component (excluding egg, see details above)
  - Receiving aspirin or salicylate-containing medications
  - Age 2–4 years with history of asthma or wheezing
  - Immunocompromised due to any cause (including medications and HIV infection)
  - Anatomic or functional asplenia
  - Close contacts or caregivers of severely immunosuppressed persons who require a protected environment
  - Pregnancy
  - Cochlear implant
  - Cerebrospinal fluid-oropharyngeal communication
  - Children less than age 2 years
  - Received influenza antiviral medications oseltamivir or zanamivir within the previous 48 hours,. peramivir within the previous 5 days, or baloxavir within the previous 17 days

Notes

Measles, mumps, and rubella vaccination (minimum age: 12 months for routine vaccination)

Routine vaccination
- 2-dose series at 12–15 months, 4–6 years
- Dose 2 may be administered as early as 4 weeks after dose 1.

Catch-up vaccination
- Unvaccinated children and adolescents: 2-dose series at least 4 weeks apart
- The maximum age for use of MMRV is 12 years.

Special situations
International travel
- **Infants age 6–11 months:** 1 dose before departure; revaccinate with 2-dose series at age 12–15 months (12 months for children in high-risk areas) and dose 2 as early as 4 weeks later.
- **Unvaccinated children age 12 months or older:** 2-dose series at least 4 weeks apart before departure

Meningococcal serogroup A,C,W,Y vaccination (minimum age: 2 months [MenACWY-CRM, Menveo], 9 months [MenACWY-D, Menactra], 2 years [MenACWY-TT, MenQuadfi])

Routine vaccination
- 2-dose series at 11–12 years, 16 years

Catch-up vaccination
- Age 13–15 years: 1 dose now and booster at age 16–18 years (minimum interval: 8 weeks)
- Age 16–18 years: 1 dose

Special situations
Anatomic or functional asplenia (including sickle cell disease), HIV infection, persistent complement component deficiency, complement inhibitor (e.g., eculizumab, ravulizumab) use:
- **Menveo**
  - Dose 1 at age 8 weeks: 4-dose series at 2, 4, 6, 12 months
  - Dose 1 at age 3–6 months: 3- or 4- dose series (dose 2 [and dose 3 if applicable] at least 8 weeks after previous dose until a dose is received at age 7 months or older, followed by an additional dose at least 12 weeks later and after age 12 months)
  - Dose 1 at age 7–23 months: 2-dose series (dose 2 at least 12 weeks after dose 1 and after age 12 months)
  - Dose 1 at age 24 months or older: 2-dose series at least 8 weeks apart
- **Menactra**
  - **Persistent complement component deficiency or complement inhibitor use:**
    - Age 9–23 months: 2-dose series at least 12 weeks apart
    - Age 24 months or older: 2-dose series at least 8 weeks apart
  - **Anatomic or functional asplenia, sickle cell disease, or HIV infection:**
    - Age 9–23 months: Not recommended
    - Age 24 months or older: 2-dose series at least 8 weeks apart
    - **Menactra** must be administered at least 4 weeks after completion of PCV13 series.
- **MenQuadfi**
  - Dose 1 at age 24 months or older: 2-dose series at least 8 weeks apart

Travel in countries with hyperendemic or epidemic meningococcal disease, including countries in the African meningitis belt or during the Hajj (www.cdc.gov/travel/)**:**
- Children less than age 24 months:
  - **Menveo (age 2–23 months)**
    - Dose 1 at age 8 weeks: 4-dose series at 2, 4, 6, 12 months
    - Dose 1 at age 3–6 months: 3- or 4- dose series (dose 2 [and dose 3 if applicable] at least 8 weeks after previous dose until a dose is received at age 7 months or older, followed by an additional dose at least 12 weeks later and after age 12 months)
    - Dose 1 at age 7–23 months: 2-dose series (dose 2 at least 12 weeks after dose 1 and after age 12 months)
  - **Menactra (age 9–23 months)**
    - 2-dose series (dose 2 at least 12 weeks after dose 1; dose 2 may be administered as early as 8 weeks after dose 1 in travelers)
- Children age 2 years or older: 1 dose Menveo, Menactra, or MenQuadfi

First-year college students who live in residential housing (if not previously vaccinated at age 16 years or older) or military recruits:
- 1 dose **Menveo, Menactra,** or **MenQuadfi**

Adolescent vaccination of children who received MenACWY prior to age 10 years:
- **Children for whom boosters are recommended** because of an ongoing increased risk of meningococcal disease (e.g., those with complement deficiency, HIV, or asplenia): Follow the booster schedule for persons at increased risk.
- **Children for whom boosters are not recommended** (e.g., a healthy child who received a single dose for travel to a country where meningococcal disease is endemic): Administer MenACWY according to the recommended adolescent schedule with dose 1 at age 11–12 years and dose 2 at age 16 years.

Note: Menactra should be administered either before or at the same time as DTaP. For MenACWY **booster dose recommendations** for groups listed under "Special situations" and in an outbreak setting and additional meningococcal vaccination information, see www.cdc.gov/mmwr/volumes/69/rr/rr6909a1.htm.

Meningococcal serogroup B vaccination (minimum age: 10 years [MenB-4C, Bexsero; MenB-FHbp, Trumenba])

Shared clinical decision-making
- **Adolescents not at increased risk** age 16–23 years (preferred age 16–18 years) based on shared clinical decision-making:
  - **Bexsero:** 2-dose series at least 1 month apart
  - **Trumenba:** 2-dose series at least 6 months apart; if dose 2 is administered earlier than 6 months, administer a 3rd dose at least 4 months after dose 2.

Special situations
Anatomic or functional asplenia (including sickle cell disease), persistent complement component deficiency, complement inhibitor (e.g., eculizumab, ravulizumab) use:
- **Bexsero:** 2-dose series at least 1 month apart
- **Trumenba:** 3-dose series at 0, 1–2, 6 months

Bexsero and **Trumenba** are not interchangeable; the same product should be used for all doses in a series.
For MenB **booster dose recommendations** for groups listed under "Special situations" and in an outbreak setting and additional meningococcal vaccination information, see www.cdc.gov/mmwr/volumes/69/rr/rr6909a1.htm.

Pneumococcal vaccination (minimum age: 6 weeks [PCV13], 2 years [PPSV23])

Routine vaccination with PCV13
- 4-dose series at 2, 4, 6, 12–15 months

Catch-up vaccination with PCV13
- 1 dose for healthy children age 24–59 months with any incomplete* PCV13 series
- For other catch-up guidance, see Table 2.

Special situations
Underlying conditions below: When both PCV13 and PPSV23 are indicated, administer PCV13 first. PCV13 and PPSV23 should not be administered during same visit.

Chronic heart disease (particularly cyanotic congenital heart disease and cardiac failure); chronic lung disease (including asthma treated with high-dose, oral corticosteroids); diabetes mellitus:

Age 2–5 years
- Any incomplete* series with:
  - 3 PCV13 doses: 1 dose PCV13 (at least 8 weeks after any prior PCV13 dose)
  - Less than 3 PCV13 doses: 2 doses PCV13 (8 weeks after the most recent dose and administered 8 weeks apart)
- No history of PPSV23: 1 dose PPSV23 (at least 8 weeks after completing all recommended PCV13 doses)

Age 6–18 years
- •No history of PPSV23: 1 dose PPSV23 (at least 8 weeks after completing all recommended PCV13 doses)

Cerebrospinal fluid leak, cochlear implant:

Age 2–5 years
- Any incomplete* series with:
  - 3 PCV13 doses: 1 dose PCV13 (at least 8 weeks after any prior PCV13 dose)
  - Less than 3 PCV13 doses: 2 doses PCV13 (8 weeks after the most recent dose and administered 8 weeks apart)
- No history of PPSV23: 1 dose PPSV23 (at least 8 weeks after any prior PCV13 dose)

Age 6–18 years
- No history of either PCV13 or PPSV23: 1 dose PCV13, 1 dose PPSV23 at least 8 weeks later
- Any PCV13 but no PPSV23: 1 dose PPSV23 at least 8 weeks after the most recent dose of PCV13
- PPSV23 but no PCV13: 1 dose PCV13 at least 8 weeks after the most recent dose of PPSV23

Notes

Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2021

Sickle cell disease and other hemoglobinopathies; anatomic or functional asplenia; congenital or acquired immunodeficiency; HIV infection; chronic renal failure; nephrotic syndrome; malignant neoplasms, leukemias, lymphomas, Hodgkin disease, and other diseases associated with treatment with immunosuppressive drugs or radiation therapy; solid organ transplantation; multiple myeloma:

Age 2–5 years

- Any incomplete* series with:
  - 3 PCV13 doses: 1 dose PCV13 (at least 8 weeks after any prior PCV13 dose)
  - Less than 3 PCV13 doses: 2 doses PCV13 (8 weeks after the most recent dose and administered 8 weeks apart)
- No history of PPSV23: 1 dose PPSV23 (at least 8 weeks after any prior PCV13 dose) and a 2nd dose of PPSV23 5 years later

Age 6–18 years

- No history of either PCV13 or PPSV23: 1 dose PCV13, 2 doses PPSV23 (dose 1 of PPSV23 administered 8 weeks after PCV13 and dose 2 of PPSV23 administered at least 5 years after dose 1 of PPSV23)
- Any PCV13 but no PPSV23: 2 doses PPSV23 (dose 1 of PPSV23 administered 8 weeks after the most recent dose of PCV13 and dose 2 of PPSV23 administered at least 5 years after dose 1 of PPSV23)
- PPSV23 but no PCV13: 1 dose PCV13 at least 8 weeks after the most recent PPSV23 dose and a 2nd dose of PPSV23 administered 5 years after dose 1 of PPSV23 and at least 8 weeks after a dose of PCV13

Chronic liver disease, alcoholism:

Age 6–18 years

- No history of PPSV23: 1 dose PPSV23 (at least 8 weeks after any prior PCV13 dose)

**Incomplete series* = Not having received all doses in either the recommended series or an age-appropriate catch-up series See Tables 8, 9, and 11 in the ACIP pneumococcal vaccine recommendations (www.cdc.gov/mmwr/pdf/rr/rr5911.pdf) for complete schedule details.

Poliovirus vaccination (minimum age: 6 weeks)

Routine vaccination

- 4-dose series at ages 2, 4, 6–18 months, 4–6 years; administer the final dose on or after age 4 years and at least 6 months after the previous dose.
- 4 or more doses of IPV can be administered before age 4 years when a combination vaccine containing IPV is used. However, a dose is still recommended on or after age 4 years and at least 6 months after the previous dose.

Catch-up vaccination

- In the first 6 months of life, use minimum ages and intervals only for travel to a polio-endemic region or during an outbreak.
- IPV is not routinely recommended for U.S. residents age 18 years or older.

Series containing oral polio vaccine (OPV), either mixed OPV-IPV or OPV-only series:

- Total number of doses needed to complete the series is the same as that recommended for the U.S. IPV schedule. See www.cdc.gov/mmwr/volumes/66/wr/mm6601a6.htm?s_%20cid=mm6601a6_w.
- Only trivalent OPV (tOPV) counts toward the U.S. vaccination requirements.
  - Doses of OPV administered before April 1, 2016, should be counted (unless specifically noted as administered during a campaign).
  - Doses of OPV administered on or after April 1, 2016, should not be counted.
  - For guidance to assess doses documented as "OPV," see www.cdc.gov/mmwr/volumes/66/wr/mm6606a7.htm?s_cid=mm6606a7_w.
- For other catch-up guidance, see Table 2.

Rotavirus vaccination (minimum age: 6 weeks)

Routine vaccination

- **Rotarix:** 2-dose series at 2 and 4 months
- **RotaTeq:** 3-dose series at 2, 4, and 6 months
- If any dose in the series is either **RotaTeq** or unknown, default to 3-dose series.

Catch-up vaccination

- Do not start the series on or after age 15 weeks, 0 days.
- The maximum age for the final dose is 8 months, 0 days.
- For other catch-up guidance, see Table 2.

Tetanus, diphtheria, and pertussis (Tdap) vaccination (minimum age: 11 years for routine vaccination, 7 years for catch-up vaccination)

Routine vaccination

- **Adolescents age 11–12 years:** 1 dose Tdap
- **Pregnancy:** 1 dose Tdap during each pregnancy, preferably in early part of gestational weeks 27–36
- Tdap may be administered regardless of the interval since the last tetanus- and diphtheria-toxoid-containing vaccine.

Catch-up vaccination

- **Adolescents age 13–18 years who have not received Tdap:** 1 dose Tdap, then Td or Tdap booster every 10 years
- **Persons age 7–18 years not fully vaccinated* with DTaP:** 1 dose Tdap as part of the catch-up series (preferably the first dose); if additional doses are needed, use Td or Tdap.
- **Tdap administered at age 7–10 years:**
  - **Children age 7–9 years** who receive Tdap should receive the routine Tdap dose at age 11–12 years.
  - **Children age 10 years** who receive Tdap do not need the routine Tdap dose at age 11–12 years.
- **DTaP inadvertently administered on or after age 7 years**:
  - **Children age 7–9 years**: DTaP may count as part of catch-up series. Administer routine Tdap dose at age 11–12 years.
  - **Children age 10–18 years**: Count dose of DTaP as the adolescent Tdap booster.
- For other catch-up guidance, see Table 2.

Special situations

- **Wound management** in persons age 7 years or older with history of 3 or more doses of tetanus-toxoid-containing vaccine: For clean and minor wounds, administer Tdap or Td if more than 10 years since last dose of tetanus-toxoid-containing vaccine; for all other wounds, administer Tdap or Td if more than 5 years since last dose of tetanus-toxoid-containing vaccine. Tdap is preferred for persons age 11 years or older who have not previously received Tdap or whose Tdap history is unknown. If a tetanus-toxoid-containing vaccine is indicated for a pregnant adolescent, use Tdap.
- For detailed information, see www.cdc.gov/mmwr/volumes/69/wr/mm6903a5.htm.

**Fully vaccinated* = 5 valid doses of DTaP OR 4 valid doses of DTaP if dose 4 was administered at age 4 years or older

Varicella vaccination (minimum age: 12 months)

Routine vaccination

- 2-dose series at 12–15 months, 4–6 years
- Dose 2 may be administered as early as 3 months after dose 1 (a dose administered after a 4-week interval may be counted).

Catch-up vaccination

- Ensure persons age 7–18 years without evidence of immunity (see *MMWR* at www.cdc.gov/mmwr/pdf/rr/rr5604.pdf) have a 2-dose series:
  - **Age 7–12 years**: routine interval: 3 months (a dose administered after a 4-week interval may be counted)
  - **Age 13 years and older**: routine interval: 4–8 weeks (minimum interval: 4 weeks)
  - The maximum age for use of MMRV is 12 years.

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AAP News

Health officials, AAP urge COVID-19 vaccination despite rare myocarditis cases

by Melissa Jenco, News Content Editor

Editor's note:*For the latest news on COVID-19, visit http://bit.ly/AAPNewsCOVID19.*

Federal health officials are adding new clinical guidance on the potential for myocarditis after COVID-19 vaccination for adolescents and young adults, while continuing to urge youths to get vaccinated.

"The facts are clear: this is an extremely rare side effect, and only an exceedingly small number of people will experience it after vaccination," health officials and medical organizations said in a statement Wednesday. "Importantly, for the young people who do, most cases are mild, and individuals recover often on their own or with minimal treatment. In addition, we know that myocarditis and pericarditis are much more common *if you get COVID-19*, and the risks to the heart from COVID-19 infection can be more severe."

The statement was signed by leaders of the Department of Health and Human Services, the Centers for Disease Control and Prevention (CDC), the AAP and other medical and public health groups. It followed an in-depth discussion by the CDC's Advisory Committee on Immunization Practices (ACIP) on myocarditis cases after COVID-19 vaccination.

Myocarditis/pericarditis cases after vaccination

In total, 1,226 cases of myocarditis or pericarditis have been reported to the Vaccine Adverse Event Reporting System (VAERS) after administration of about 300 million doses of mRNA COVID-19 vaccines from Pfizer-BioNTech and Moderna. However, not all of them have been verified.

The cases have been seen predominantly in male adolescents and young adults. They occur more after the second dose than the first and typically appear within a week of vaccination, according to Tom Shimabukuro, M.D., M.P.H., M.B.A., deputy director of the CDC's Immunization Safety Office.

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AAP News

Of 484 reports in people under age 30, 323 have met CDC case definition and 148 are under review. The most common symptoms were chest pain, elevated cardiac enzymes, ST or T wave changes, dyspnea and abnormal echocardiography/imaging.

Of the 323 confirmed cases, 309 patients were hospitalized and 295 of them have been discharged. About 79% of those discharged have recovered. Nine remain hospitalized, and data were not available for five.

Cases of myocarditis/pericarditis within seven days after a second dose are higher than what would otherwise be expected for adolescents and young adults, according to CDC experts.

The CDC also looked at the reporting rate of myocarditis/pericarditis in relation to the number of doses administered. For every 1 million second doses of COVID-19 vaccine, there have been about 67 reported cases in males ages 12-17 years, 56 cases in males ages 18-24 years and 20 cases in males ages 25-29 years, according to VAERS data including both confirmed and unconfirmed cases The rates for females were nine, six and three cases, respectively.

COVID-19 vaccine benefits

CDC experts also highlighted the benefits of the COVID-19 vaccines in preventing a potentially deadly disease. Since the start of the pandemic, at least 7.7 million people ages 12-29 years have been diagnosed with COVID-19 and 2,767 have died, according to the CDC. There also have been just over 4,000 cases of multisystem inflammatory syndrome in children following a SARS-CoV-2 infection.

In females ages 12-17 years, the CDC estimates every 1 million second doses could prevent 8,500 infections, 183 hospitalizations and one death in females. Every 1 million second doses would prevent 5,700 infections, 215 hospitalizations and two deaths in 12- to 17-year-old males.

"There are no alternatives to mRNA vaccines for the foreseeable future in adolescents," said Megan Wallace, Dr.P.H., M.P.H., from CDC's National Center for Immunization and Respiratory Diseases. "Vaccination of students offers an additional layer of protection against COVID-19 and can be important tool to return to normal. Higher levels of vaccination coverage can lead to less community transmission, which can protect against development and circulation of emerging variants."

ACIP members said they felt the benefits of COVID-19 vaccination outweigh the risks of myocarditis/pericarditis and applauded the national surveillance systems that picked up on the cases.

"Folks should have confidence in the systems that are in place and our processes," said Grace M. Lee, M.D., M.P.H., co-chair of ACIP's Vaccine Safety Technical Work Group and associate chief medical officer for practice innovation at Stanford Children's Health. "There is continuous and ongoing monitoring of vaccine safety for all vaccinations in the U.S."

Clinical recommendations

The FDA plans to add warnings to COVID-19 fact sheets for clinicians and patients explaining the small risk of myocarditis or pericarditis.

The CDC recommends people with a history of myocarditis or pericarditis who have recovered still get vaccinated. People who have pericarditis after the first dose of COVID-19 vaccine can receive a second dose after their symptoms resolve. Those who experience myocarditis after the first dose could consider getting the second dose under certain circumstances, if the heart has recovered. Patients experiencing either condition after the first dose should discuss additional vaccination with their clinician.

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Resources

- The AAP will hold a town hall on COVID-19 at 7 p.m. CDT on June 24.
- CDC guidance for clinicians on myocarditis after COVID-19 vaccination
- Information from the CDC on clinical considerations for COVID-19 vaccines
- CDC COVID vaccination toolkit for pediatricians
- AAP guidance on providing COVID-19 vaccines to adolescents
- Information for parents from HealthyChildren.org on myocarditis after vaccination
- Information for parents from HealthyChildren.org on preparing children and adolescents for COVID-19 vaccination

Immunization Case Scenarios

Case I

You are seeing a 3 yo Dana for a well child visit. She has never received any vaccines, but after much soul-searching, her parents have agreed to ensure she is up to date. What vaccine would you prescribe today?

Should Have Received	Can Receive Today
–3 HepB @ birth, 1-2 mo, & 6-18 mo	1 Hep B
–3 RotaTeq@ 2, 4, & 6mo	NONE (don't give >32 wks)
–4 DTaP@ 2, 4, 6mo & 15-18mo	1 DTaP (no 5th dose if 4th >4yr)
–3 Hib@ 2, 4, & 12-15 mo	1 Hib (no 2nd dose if 1st >15mo)
–4 PCV-13 @ 2, 4, 6, & 12-15 mo	1 PCV (no 2nd dose if 1st>24mo)
–3 IPV @ 2, 4, & 6-18 mo	1 IPV (no 4th dose if 3rd >4yr)
–1 MMR @ 12mo	1 MMR
–1 Varicella@ 12mo	1 VZV
–2 HepA @ 12-23mo	1 Hep A

Discussion Points

* Residents can discuss which of the vaccines in the "can receive today" column would be "most important" to receive, since all 8 vaccines probably should not be received at once. This decision may be based on prevalence of disease in community, likely exposures, etc. Also discuss which vaccines are available in combination (Pediarix, MMRV.)

Emphasize the importance of recommending the annual Flu shot as well.

* **Combination Vaccine Table**

When would you schedule the next visit? What would you prescribe at that visit?

4 weeks. HepB, DTaP, IPV. (MMR and VZV given per usual at 4-6yrs; HepA in 6mo).

Case II

You are seeing 4 yo DeAndre who has sickle cell anemia. He has received DTaP x 4, IPV x 3, MMR, Varivax, and Hib x 3. What vaccines would you prescribe today?

Should Have Received	Y/N	Can Receive Today
–3 HepB @ birth, 1-2 mo, & 6-18 mo	0	1 Hep B
–3 RotaTeq@ 2, 4, & 6mo	0	NONE (don't give >32 wks)
–4 DTaP@ 2, 4, 6mo & 15-18mo + *1DTaP (4-6 yr)*	4	1 DTaP
–3 Hib@ 2, 4, & 12-15 mo *if PRP-OMP series*	3	1 Hib? (4th dose only if #1-3 @<12mo)
–4 PCV-13 @2, 4, 6, & 12-18 mo ***+ 1 PPV23 (>2yr)***	0	**1 PCV-13**
–3 IPV @ 2, 4, & 6-18 mo + *1 IPV (4-6yrs)*	3	1 IPV
–1 MMR @ 12mo + *1 MMR (4-6yrs)*	1	1 MMR
–1 Varicella@ 12mo + *1 VZV (4-6yrs)*	1	1 VZV
- Yearly Influenza	0	1 Influenza
–2 HepA @ 12-23mo	0	1 Hep A
- 2 MCV4 @ ≥2yrs	0	**1 MCV4**

Key Points for Sickle Cell Patients:

- In patients 6mo or older, **influenza vaccine** should be given annually.
- **Prevnar** (PCV13) should be administered as for children without sickle cell disease.
    * For children 24-59 months, *not previously immunized* with PCV7, 13 or PPV23, give TWO doses of PCV13 2 months apart, followed by 1st dose of PPSV23 2 months later, followed by 2nd dose of PPSV23 3-5 years later.
    * For children 5+ yrs *not previously immunized* with PCV7, 13 or PPSV23, give ONE dose of PCV13, followed by 1st dose of PPSV23 2 months later, followed by 2nd dose of PPSV-2 - years later if 10yrs or years later if 10 yrs

- **Menveo** (MCV-4) was approved by the FDA in Aug 2013 for age 2-23mo (previously >2yrs), and is given to at-risk children at 2, 4, 6, and 12months of age. **Menactra**'s minimum age is 9 months.
    * For children >2yrs (this patient!) who have not received a complete meningococcal series, administer 2 primary doses of MCV-4 at least 8 weeks apart.
    * In April 2015, WR-B began to carry Trumenba (Serotype B meningococcal vaccine) intended for pts ≥10yrs with complement deficiency, asplenia, or amidst an outbreak.

Case III

You are seeing a 17 yo Anthony for a college physical. He has received DTaP x 5, IPV x 4, MMR x 2, Hib x 2. What vaccines would you prescribe?

Should Have Received	**Y/N**	**Can Receive Today**
–3 HepB @ birth, 1-2 mo, & 6-18 mo	0	1 Hep B
–3 RotaTeq@ 2, 4, & 6mo	0	NONE (don't give >32 wks)
–5 DTaP@ 2, 4, 6, 15-18mo & 4-6yr + **1Tdap (11-12yr)**	5	**1 Tdap**
–4 Hib@ 2, 4, 6, & 12-15 mo	4	not given beyond 60 months
–4 PCV-13 @ 2, 4, 6, & 12-15 mo	0	not given beyonf 60 months
–4 IPV @ 2, 4, 6-18 mo & 4-6yrs	4	COMPLETE
–2 MMR @ 12mo & 4-6yrs	2	COMPLETE
–2 Varicella@ 12mo & 4-6yrs	0	1 VZV
- Yearly Influenza	0	1 Influenza
–2 HepA @ 12-23mo	0	1 Hep A
- 2 HPV @ 11-12yrs (6 months apart)	0	**1 HPV (will need 2 more doses)**
-1 MCV4 @11-12yrs	0	**1 MCV4 and 1 MenB**

Tdap, HPV, and MCV4 are key immunizations for adolescents. Below are other notes to consider when developing "catch-up schedule" for this patient:

* HepB: Complete 3-shot series (4 weeks, 8 weeks between doses)
* Tdap: Can give booster 5 years after last DTaP
* Varicella: Complete 2-shot series (4 weeks between doses), *if no evidence of immunity*
* Hep A: Complete 2-shot series (6mo between doses)
* HPV: Complete 3-shot series (2mo, 6mo between doses)
* MCV : 2 doses at least 8 weeks apart
* Men B: Bexsero is 2 doses at least 1 month apart. Trumemba is 2 doses 6 months apart. For high risk patients, 3 doses with one month between doses 1 and 2, and six months between doses 1 and 3.

Case IV

You are seeing 22 mo Maggie who was adopted from China. Her translated immunization booklet indicates that she received DTap x 3, IPV x 3, Hib x 3, HepB x 3, MMR x 1, **BCG x 1**, and varivax x 1. What would you prescribe today?

Should Have Received	**Y/N**	**Can Receive Today**
–3 HepB @ birth, 1-2 mo, & 6-18 mo	3	"COMPLETED"
-Rotavirus, 2 or three doses	0	NONE (don't give >32 wks)
–4 DTaP@ 2, 4, 6mo & 15-18mo	3	1 DTaP
–3 Hib@ 2, 4, & 12-15 mo	3	1 Hib? (4th dose only if #1-3 @<12mo)
–4 PCV-13 @ 2, 4, 6, & 12-15 mo	0	1 PCV-13
–3 IPV @ 2, 4, & 6-18 mo	3	"COMPLETED"
–1 MMR @ 12mo	0	"COMPLETED"
–1 Varicella@ 12mo	0	"COMPLETED"
–2 HepA @ 12-23mo	0	1 Hep A

From Red Book: Medical Evaluation of Internationally Adopted Children for Infectious Diseases.

- **PPD** or serum quatiferon (this should be done even if the child was immunized with the **BCG vaccine**).
- Evaluate immunization status by **checking antibody titers** for vaccines previously given (eg, diphtheria, tetanus, polio neutralizing titers) **OR repeat immunizations.** *(Exceptions may include children from foster homes in Korea and Guatemala.)*

Testing for **tuberculosis, Hepatitis B, Hepatitis C, and HIV** should be repeated after the child has been home 6 months. (Some children may not respond initially if the incubation period is inadequate or if they are malnourished.)

See CDC website for other options: **https://www.cdc.gov/immigrantrefugeehealth**

"**Written records are more likely to predict protection if the vaccines, dates of administration, intervals between doses, and age at the time of vaccination are comparable to U.S. recommendations.** Although vaccines with inadequate potency have been produced in other countries, the majority of vaccines used worldwide are produced with adequate quality control standards and are potent. . . Health-care providers may use one of multiple approaches if the immunogenicity of vaccines administered to persons outside the United States is in question. Repeating the vaccinations is an acceptable option that usually is safe and prevents the need to obtain and interpret serologic tests. If avoiding unnecessary injections is desired, judicious use of serologic testing might help determine which vaccinations are needed. For some vaccines, the most readily available serologic tests cannot document protection against infection."

Board Review Questions:

1. A family comes to your office for consultation regarding a 3-week trip to India they are planning to take in 3 months. The children, a 9-year-old boy and a 7-month-old girl, are well, and their immunizations are up to date.

Of the following, the MOST appropriate prophylaxis to provide in preparation for travel is :

A. chloroquine for both children
B. hepatitis A vaccination for both children
C. measles vaccination for the girl
D. polio vaccination for the boy
E. typhoid vaccine for both children

Protection against infectious diseases is an important issue in preparing children and adults for international travel. Clinicians can obtain specific knowledge of available vaccines and prophylaxis for certain conditions from the American Academy of Pediatrics *2009 Report of the Committee on Infectious Diseases (Red Book®)* and the travelers' health site of the Centers for Disease Control and Prevention. Travel to India involves a potentially increased exposure to malaria, hepatitis A, measles, polio, and *Salmonella typhi*. However, there are other considerations in recommending various preventive measures for travelers.

Measles may be encountered more commonly in many parts of the world, including India. Accordingly, measles vaccine is recommended for 6- to 11-month-old children, and the 7-month-old girl in the vignette should be given a dose of measles vaccine. She still will require two doses of measles-containing vaccine after 1 year of age because the immune response may be suboptimal at her young age. If the 9-year-old boy is up to date on immunizations, he requires no additional measles vaccination.

Although exposure to malaria is a concern on a prolonged trip to India, resistance to chloroquine is a major concern in this region, as it is in all of South and Southeast Asia, sub-Saharan Africa, and tropical areas of South America. Available agents for resistant malaria prophylaxis in infants and children include atovaquone/proguanil and mefloquine. Doxycycline can be used in children older than 8 years of age.

Hepatitis A is a concern, but hepatitis A vaccine is not approved in children younger than 1 year of age. Intramuscular immunoglobulin is recommended for children younger than 1 year of age, as the baby in the vignette, traveling to an endemic area. The boy should receive his first dose of hepatitis A vaccine at least 2 to 4 weeks before departure if he has not been immunized previously, with completion of the two-dose series 6 to 12 months later.

Although polio exposure may be a concern, if both children are up to date in their vaccination series, no additional polio vaccine is indicated. Finally, typhoid vaccine might be indicated for a trip to India that lasts longer than 2 weeks, but neither of the two licensed vaccines is indicated in children younger than 2 years of age.

2. A 14-year-old girl presents to your emergency department for evaluation of a 3-week history of progressive episodes of coughing spasms. She reports several episodes of post-tussive vomiting and difficulty sleeping at night. She denies night sweats or weight loss and says she was previously well. She does not take any medications.

Of the following, the MOST important additional information to obtain is a history of:

A. gastroesophageal reflux disease
B. international travel over the past year
C. pet or animal exposures
D. spelunking trips in the last 6 months
E. **vaccinations received since 11 years of age**

The progressive paroxysmal cough progressing over 3 weeks accompanied by posttussive vomiting reported by the girl in the vignette is typical for adolescent pertussis. The duration of disease is 6 to 10 weeks, and complications in adolescents and adults may include sleep disturbances, secondary pneumonia, and vomiting. Immunity to pertussis wanes 6 or more years after vaccination, which makes adolescents and adults susceptible after completing the recommended childhood pertussis vaccine series at 4 to 6 years of age.

In recognition of the increased occurrence of pertussis in this age range and with the demonstrated safety and efficacy of attenuated acellular pertussis booster vaccines (ie, tetanus toxoid, reduced diphtheria toxoid, acellular pertussis [Tdap]), the Advisory Committee on Immunization Practices of the Centers for Disease Control and Prevention recommended in 2005 that a single dose of Tdap be administered at the routine 11- to 12-year-old health supervision visit. A single dose of Tdap also should be administered more than 5 years after the last tetanus toxoid, reduced diphtheria toxoid (Td) dose for individuals up to 64 years of age. In high-risk situations, the dose can be administered as soon as 2 years after the last Td vaccination. Accordingly, determining whether the girl in the vignette has received a dose of Tdap since 11 years of age would help confirm the suspicion of pertussis.

The most common signs and symptoms of gastroesophageal reflux are heartburn, regurgitation, and dysphagia, not primarily coughing spasms. A history of international travel might help support concerns of exposure to tuberculosis. In addition, such travel might increase the individual's exposure to other respiratory agents such as influenza (based on seasonality and hemisphere) and other vaccine-preventable diseases such as pertussis, but supporting the diagnosis of pertussis would be better aided by knowing the history of Tdap immunization. A number of respiratory infections can be transmitted to people from pets or animals (eg, Q fever, Bordetella bronchiseptica), but these infections are much less common than pertussis and are not as consistent with the clinical illness described. Spelunking (or caving) in areas of the eastern and central United States may increase the risk for exposure to histoplasmosis from bird or bat droppings in the caves. Clinically, histoplasmosis in the healthy host usually is asymptomatic. Acute pulmonary histoplasmosis presents with more of an influenza-like illness that resolves over 2 days to 2 weeks.

3. A 6-month-old boy presents to the emergency department with a 2-day history of fever and a 1-day history of left cheek swelling. You discover that his parents do not believe in providing their children with immunizations. Despite this, the boy has never been ill. He has two older siblings, and nobody is sick at home. The mother denies any recent bug bites or trauma to the area on his cheek. Physical examination reveals a mildly toxic-appearing child who has a temperature of 103.0°F (39.4°C), heart rate of 145 beats/min, respiratory rate of 26 breaths/min, and blood pressure of 80/45 mm Hg. His anterior fontanelle is slightly bulging, his tympanic membranes are erythematous, his left cheek is indurated and appears erythematous to slightly violaceous, and he is irritable.

Of the following, the MOST likely organism to cause this child's illness is :

A. ***Haemophilus influenzae*** **type b**
B. *Neisseria meningitidis*
C. *Staphylococcus aureus*
D. *Streptococcus pneumoniae*
E. *Streptococcus pyogenes*

Children who have not received the *Haemophilus influenzae* type b (Hib) vaccine are at risk for illnesses commonly caused by this organism, including buccal and periorbital cellulitis (as described for the boy in the vignette), pyogenic arthritis, epiglottitis, and bacterial meningitis. *Neisseria meningitidis* usually does not cause a facial cellulitis, and *Staphylococcus aureus* and *Streptococcus pyogenes* are less likely pathogens in the absence of a history of a break in the skin. *S pneumoniae* can be the cause of a nontraumatic facial cellulitis in Hib-vaccinated children, but in an unvaccinated child, Hib would be the most likely pathogen.

Hib disease can be verified by recovery of the organism from a sterile site (eg, blood, cerebrospinal fluid, joint fluid) or by urine antigen testing. Once the organism is isolated, antimicrobial susceptibility testing is important because approximately 30% to 40% of Hib isolates produce beta-lactamase, making these organisms resistant to ampicillin.

4. A mother calls you to report that her 7-year-old son came home with a notice from school stating that a child in his class was diagnosed with mumps. The mother does not know the immunization status of the infected child but states that her son has received two measles-mumps-rubella (MMR) vaccines and is up to date on all his other immunizations. Her son has been asymptomatic, with no fever or other systemic complaints.

Of the following, the MOST appropriate action is to:

A. administer a dose of mumps immune globulin to her son
B. **confirm that her son has received two doses of MMR vaccine**
C. keep her son home from school for 9 days to observe for the development of symptoms
D. treat her son with a course of ribavirin
E. vaccinate her son immediately with another dose of MMR to prevent infection from this exposure

In the United States, mumps vaccine is administered as part of the measles-mumps-rubella (MMR) vaccine routinely to children at 12 to 15 months of age, with a second dose of MMR typically administered at 4 to 6 years of age. Protective efficacy of the vaccine is estimated to be more than 95%. In cases of exposure, such as described in the vignette, it is important to ensure that the exposed person has received the recommended number of doses of MMR vaccine because mumps outbreaks have occurred in people in highly immunized populations who previously have received only a single dose of mumps-containing vaccine. Therefore, the most appropriate action is to confirm with the mother that her son has received two doses of MMR vaccine.

Mumps vaccine has not been demonstrated to be effective in preventing infection after exposure. However, the vaccine can be administered after exposure to provide protection against subsequent exposures in persons who are not fully vaccinated. Fully immunized persons do not need to be excluded from school after exposure. Students who are not fully immunized are excluded from school until they are immunized, after which they can be readmitted immediately to school. Students who refuse mumps vaccination because of medical, religious, or other reasons should be excluded from school for at least 26 days after the onset of parotitis in the last person who has mumps in the affected school. Persons who have mumps are excluded from school for 9 days from the onset of their parotid swelling.

Immune globulin (IG) and mumps IG are not effective as postexposure prophylaxis measures. In fact, mumps IG no longer is available in the United States. Treatment of the disease is supportive; no effective antiviral agents are available.

5. You are hiring a pediatrician as a hospitalist at a community hospital.

Of the following, the disease for which immune status MUST be documented at the time of employment is:

A. diphtheria
B. hepatitis A
C. measles
D. meningococcal disease
E. tetanus

Health-care personnel are in contact with patients who may have contagious, vaccine-preventable diseases and are at increased risk for contracting such diseases. Further, the employee who becomes infected is at risk for transmitting the disease to other patients who are susceptible to the disease. Therefore, all health-care personnel should protect themselves and susceptible patients by receiving appropriate immunizations. The vaccine-preventable infections that are of special concern to people involved in the health care of children include rubella, measles, mumps, hepatitis B, influenza, varicella, and tuberculosis. The immune status of the health-care worker against these diseases should be documented at the time of employment.

Persons found to be susceptible should receive the appropriate vaccine or vaccine series for the disease to which they are susceptible. Diphtheria, hepatitis A, meningococcal disease, and tetanus are not commonly transmitted by patients in a health-care setting and do not require documentation of immune status.