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:
  - "Immunizations: Vaccinations in General" (*Pediatrics in Review, 2015*)
  - Recommended Child and Adolescent Immunization Schedule, 2023 (CDC)
  - COVID-19 Vaccine: Interim COVID-19 vaccination schedule for 6 Months of Age and Older (CDC)
- 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 MHS Genesis.

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.)*
- CDC Vaccine Abbreviations (U.S) *(good for decoding shot records) and* International Decoding
- "Rationale for the Immunization Schedule:: Why Is It the Way It Is"? *(PIR, 2019)*
- "Association of the COVID-19 Pandemic With Routine Childhood Vaccination Rates and Proportion Up to Date with Vaccinations Across 8 US Health Systems in the Vaccine Safety Datalink" *(JAMA Pediatrics, 2022)*
- Immunization Coverage *(World Health Organization)*
- "Impact of Routine Childhood Immunization in Reducing Vaccine Preventable Diseases in the United States" *(Pediatrics, 2022)*

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.

COVID-19 vaccination recommendations have changed. Find the latest recommendations at www.cdc.gov/covidschedule

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

UNITED STATES 2023

Vaccines in the Child and Adolescent Immunization Schedule*

Vaccine	Abbreviation(s)	Trade name(s)
COVID-19	**1vCOV-mRNA**	Comirnaty®/Pfizer-BioNTech COVID-19 Vaccine
		SPIKEVAX®/Moderna COVID-19 Vaccine
	2vCOV-mRNA	Pfizer-BioNTech COVID-19 Vaccine, Bivalent
		Moderna COVID-19 Vaccine, Bivalent
	1vCOV-aPS	Novavax COVID-19 Vaccine
Dengue vaccine	**DEN4CYD**	Dengvaxia®
Diphtheria, tetanus, and acellular pertussis vaccine	**DTaP**	Daptacel® Infanrix®
Diphtheria, tetanus vaccine	**DT**	No trade name
Haemophilus influenzae type b vaccine	**Hib (PRP-T)**	ActHIB® Hiberix®
	Hib (PRP-OMP)	PedvaxHIB®
Hepatitis A vaccine	**HepA**	Havrix® Vaqta®
Hepatitis B vaccine	**HepB**	Engerix-B® Recombivax HB®
Human papillomavirus vaccine	**HPV**	Gardasil 9®
Influenza vaccine (inactivated)	**IIV4**	Multiple
Influenza vaccine (live, attenuated)	**LAIV4**	FluMist® Quadrivalent
Measles, mumps, and rubella vaccine	**MMR**	M-M-R II® Priorix®
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 conjugate vaccine	**PCV13** **PCV15**	Prevnar 13® Vaxneuvance™
Pneumococcal 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 and 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 or other indication **(Table 3)**
4. Review vaccine types, frequencies, intervals, and considerations for special situations **(Notes)**
5. Review contraindications and precautions for vaccine types **(Appendix)**

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 Associates (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

Questions or comments

Contact www.cdc.gov/cdc-info or 800-CDC-INFO (800-232-4636), in English or Spanish, 8 a.m.–8 p.m. ET, Monday through Friday, excluding holidays

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

Helpful information

- Complete Advisory Committee on Immunization Practices (ACIP) recommendations: www.cdc.gov/vaccines/hcp/acip-recs/index.html
- *General Best Practice Guidelines for Immunization* (including contraindications and precautions): www.cdc.gov/vaccines/hcp/acip-recs/general-recs/index.html
- Vaccine information statements: www.cdc.gov/vaccines/hcp/vis/index.html
- Manual for the Surveillance of Vaccine-Preventable Diseases (including case identification and outbreak response): 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

Scan QR code for access to online schedule

CS310020-C

Table 1

COVID-19 vaccination recommendations have changed. Find the latest recommendations at www.cdc.gov/covidschedule

Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2023

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).

Vaccine	Birth	1 mo	2 mos	4 mos	6 mos	9 mos	12 mos	15 mos	18 mos	19–23 mos	2–3 yrs	4–6 yrs	7–10 yrs	11–12 yrs	13–15 yrs	16 yrs	17–18 yrs
Hepatitis B (HepB)	1st dose	◄---- 2nd dose ----►			◄---------- 3rd dose ----------►												
Rotavirus (RV): RV1 (2-dose series), RV5 (3-dose series)			1st dose	2nd dose	See Notes												
Diphtheria, tetanus, acellular pertussis (DTaP <7 yrs)			1st dose	2nd dose	3rd dose			◄---- 4th dose ----►				5th dose					
***Haemophilus influenzae* type b (Hib)**			1st dose	2nd dose	See Notes		◄-- 3rd or 4th dose, See Notes --►										
Pneumococcal conjugate (PCV13, PCV15)			1st dose	2nd dose	3rd dose		◄---- 4th dose ----►										
Inactivated poliovirus (IPV <18 yrs)			1st dose	2nd dose	◄---------- 3rd dose ----------►							4th dose					See Notes
COVID-19 (1vCOV-mRNA, 2vCOV-mRNA, 1vCOV-aPS)					2- or 3- dose primary series and booster (See Notes)												
Influenza (IIV4)					Annual vaccination 1 or 2 doses								Annual vaccination 1 dose only				
or													**or**				
Influenza (LAIV4)											Annual vaccination 1 or 2 doses		Annual vaccination 1 dose only				
Measles, mumps, rubella (MMR)					See Notes		◄---- 1st dose ----►					2nd dose					
Varicella (VAR)							◄---- 1st dose ----►					2nd dose					
Hepatitis A (HepA)					See Notes		2-dose series, See Notes										
Tetanus, diphtheria, acellular pertussis (Tdap ≥7 yrs)														1 dose			
Human papillomavirus (HPV)														See Notes			
Meningococcal (MenACWY-D ≥9 mos, MenACWY-CRM ≥2 mos, MenACWY-TT ≥2years)			See Notes											1st dose		2nd dose	
Meningococcal B (MenB-4C, MenB-FHbp)														See Notes			
Pneumococcal polysaccharide (PPSV23)											See Notes						
Dengue (DEN4CYD; 9-16 yrs)														Seropositive in endemic dengue areas (See Notes)			

Range of recommended ages for all children

Range of recommended ages for catch-up vaccination

Range of recommended ages for certain high-risk groups

Recommended vaccination can begin in this age group

Recommended vaccination based on shared clinical decision-making

No recommendation/ not applicable

Table 2 Recommended Catch-up Immunization Schedule for Children and Adolescents Who Start Late or Who Are More than 1 Month Behind, United States, 2023

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®), Vaxelis® 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 PedvaxHIB® 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 is only necessary for children aged 12 through 59 months regardless of risk, or age 60 through 71 months with any risk, who received 3 doses before age 12 months.	
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			
Dengue	9 years	**6 months**	6 months		

Table 3

Recommended Child and Adolescent Immunization Schedule by Medical Indication, United States, 2023

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[a]		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% or total CD4 cell count of <200/mm³	≥15% and total CD4 cell count of ≥200/mm³						
Hepatitis B										
Rotavirus		SCID[b]								
Diphtheria, tetanus, and acellular pertussis (DTaP)										
Haemophilus influenzae type b										
Pneumococcal conjugate										
Inactivated poliovirus										
COVID-19		See Notes	See Notes							
Influenza (IIV4)										
or										
Influenza (LAIV4)						Asthma, wheezing: 2–4yrs[c]				
Measles, mumps, rubella	*									
Varicella	*									
Hepatitis A										
Tetanus, diphtheria, and acellular pertussis (Tdap)										
Human papillomavirus	*									
Meningococcal ACWY										
Meningococcal B										
Pneumococcal polysaccharide										
Dengue										

- 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 or vaccine. See Notes.
- Precaution–vaccine might be indicated if benefit of protection outweighs risk of adverse reaction
- Contraindicated or not recommended–vaccine should not be administered
  *Vaccinate after pregnancy
- No recommendation/not applicable

a. 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 J) at www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html.
b. Severe Combined Immunodeficiency
c. LAIV4 contraindicated for children 2–4 years of age with asthma or wheezing during the preceding 12 months

Notes

COVID-19 vaccination recommendations have changed. Find the latest recommendations at www.cdc.gov/covidschedule

Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2023

For vaccination recommendations for persons ages 19 years or older, see the Recommended Adult Immunization Schedule, 2023.

Additional information

- Consult relevant ACIP statements for detailed recommendations 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 3-2, 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, Barnett ED, Lynfield Ruth, Sawyer MH, eds. *Red Book: 2021–2024 Report of the Committee on Infectious Diseases*. 32nd ed. Itasca, IL: American Academy of Pediatrics; 2021:72–86).
- 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 vaccines included in the child and adolescent vaccine schedule are covered by VICP except dengue, PPSV23, and COVID-19 vaccines. COVID-19 vaccines that are authorized or approved by the FDA are covered by the Countermeasures Injury Compensation Program (CICP). For more information, see www.hrsa.gov/vaccinecompensation or www.hrsa.gov/cicp.

COVID-19 vaccination

(minimum age: 6 months [Moderna and Pfizer-BioNTech COVID-19 vaccines], 12 years [Novavax COVID-19 Vaccine])

Routine vaccination

- **Primary series:**
  - **Age 6 months–4 years:** 2-dose series at 0, 4-8 weeks (Moderna) or 3-dose series at 0, 3-8, 11-16 weeks (Pfizer-BioNTech)
  - **Age 5–11 years:** 2-dose series at 0, 4-8 weeks (Moderna) or 2-dose series at 0, 3-8 weeks (Pfizer-BioNTech)
  - **Age 12–18 years:** 2-dose series at 0, 4-8 weeks (Moderna) or 2-dose series at 0, 3-8 weeks (Novavax, Pfizer-BioNTech)
- For **booster dose recommendations** see www.cdc.gov/vaccines/covid-19/clinical-considerations/interim-considerations-us.html

Special situations

Persons who are moderately or severely immunocompromised

- **Primary series**
  - **Age 6 months–4 years:** 3-dose series at 0, 4, 8 weeks (Moderna) or 3-dose series at 0, 3, 11 weeks (Pfizer-BioNTech)
  - **Age 5–11 years:** 3-dose series at 0, 4, 8 weeks (Moderna) or 3-dose series at 0, 3, 7 weeks (Pfizer-BioNTech)
  - **Age 12–18 years:** 3-dose series at 0, 4, 8 weeks (Moderna) or 2-dose series at 0, 3 weeks (Novavax) or 3-dose series at 0, 3, 7 weeks (Pfizer-BioNTech)
- **Booster dose:** see www.cdc.gov/vaccines/covid-19/clinical-considerations/interim-considerations-us.html
- **Pre-exposure prophylaxis** (monoclonal antibodies) may be considered to complement COVID-19 vaccination. See www.cdc.gov/vaccines/covid-19/clinical-considerations/interim-considerations-us.html#immunocompromised

For Janssen COVID-19 Vaccine recipients see COVID-19 schedule at www.cdc.gov/vaccines/covid-19/clinical-considerations/interim-considerations-us.html

Note: Administer an age-appropriate vaccine product for each dose. Current COVID-19 schedule and dosage formulation available at www.cdc.gov/vaccines/covid-19/downloads/COVID-19-immunization-schedule-ages-6months-older.pdf. For more information on Emergency Use Authorization (EUA) indications for COVID-19 vaccines, see www.fda.gov/emergency-preparedness-and-response/coronavirus-disease-2019-covid-19/covid-19-vaccines.

Dengue vaccination

(minimum age: 9 years)

Routine vaccination

- Age 9–16 years living in areas with endemic dengue **AND** have laboratory confirmation of previous dengue infection
  - 3-dose series administered at 0, 6, and 12 months
- Endemic areas include Puerto Rico, American Samoa, US Virgin Islands, Federated States of Micronesia, Republic of Marshall Islands, and the Republic of Palau. For updated guidance on dengue endemic areas and pre-vaccination laboratory testing see www.cdc.gov/mmwr/volumes/70/rr/rr7006a1.htm?s_cid=rr7006a1_w and www.cdc.gov/dengue/vaccine/hcp/index.html
- Dengue vaccine should not be administered to children traveling to or visiting endemic dengue areas.

Diphtheria, tetanus, and pertussis (DTaP) vaccination

(minimum age: 6 weeks [4 years for Kinrix® or Quadracel®])

Routine vaccination

- 5-dose series at age 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.

Notes

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

Routine vaccination

- **ActHIB®, Hiberix®, Pentacel®, or Vaxelis®:** 4-dose series (3-dose primary series at age 2, 4, and 6 months, followed by a booster dose* at age 12–15 months)
  - *Vaxelis® is not recommended for use as a booster dose. A different Hib-containing vaccine should be used for the booster dose.
- **PedvaxHIB®:** 3-dose series (2-dose primary series at age 2 and 4 months, followed by a booster dose at age 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 age12–15 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) at least 8 weeks after dose 2.
- **2 doses of PedvaxHIB® before age 12 months:** Administer dose 3 (final dose) at age12–59 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. Vaxelis® can be used for catch-up vaccination in children less than age 5 years. Follow the catch-up schedule even if Vaxelis® is used for one or more doses. For detailed information on use of Vaxelis® see www.cdc.gov/mmwr/volumes/69/wr/mm6905a5.htm.

Special situations

- **Chemotherapy or radiation treatment:**
  Age 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):**
  Age 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:**
  Age 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:**
  Age 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)*

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

Routine vaccination

- 2-dose series (minimum interval: 6 months) at age 12–23 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)

Routine vaccination

- 3-dose series at age 0, 1–2, 6–18 months **(use monovalent HepB vaccine for doses administered before age 6 weeks)**
  - Birth weight ≥2,000 grams: 1 dose within 24 hours of birth if medically stable
  - Birth weight <2,000 grams: 1 dose at chronological age 1 month or hospital discharge (whichever is earlier and even if weight is still <2,000 grams).
- Infants who did not receive a birth dose should begin the series as soon as possible (see Table 2 for minimum intervals).
- Administration of 4 doses is permitted when a combination vaccine containing HepB is used after the birth dose.
- **Minimum intervals (see Table 2):** when 4 doses are administered, substitute "dose 4" for "dose 3" in these calculations
- **Final (3rd or 4th) dose:** age 6–18 months **(minimum age 24 weeks)**
- **Mother is HBsAg-positive**
  - **Birth dose (monovalent HepB vaccine only):** administer **HepB vaccine** and **hepatitis B immune globulin (HBIG)** (in separate limbs) within 12 hours of birth, regardless of birth weight.
  - **Birth weight <2000 grams:** administer 3 additional doses of HepB vaccine beginning at age 1 month (total of 4 doses)
  - **Final (3rd or 4th) dose:** administer at age 6 months **(minimum age 24 weeks)**
  - Test for HBsAg and anti-HBs at age 9–12 months. If HepB series is delayed, test 1–2 months after final dose. Do not test before age 9 months.

Notes

- **Mother is HBsAg-unknown**

  If other evidence suggestive of maternal hepatitis B infection exists (e.g., presence of HBV DNA, HBeAg-positive, or mother known to have chronic hepatitis B infection), manage infant as if mother is HBsAg-positive

  - **Birth dose (monovalent HepB vaccine only):**
    - Birth weight ≥2,000 grams: administer **HepB vaccine** within 12 hours of birth. Determine mother's HBsAg status as soon as possible. If mother is determined to be HBsAg-positive, administer **HBIG** as soon as possible (in separate limb), but no later than 7 days of age.
    - Birth weight <2,000 grams: administer **HepB vaccine** and **HBIG** (in separate limbs) within 12 hours of birth. Administer 3 additional doses of **HepB vaccine** beginning at age 1 month (total of 4 doses)
  - **Final (3rd or 4th) dose:** administer at age 6 months **(minimum age 24 weeks)**
  - If mother is determined to be HBsAg-positive or if status remains unknown, test for HBsAg and anti-HBs at age 9–12 months. If HepB series is delayed, test 1–2 months after final dose. Do not test before age 9 months.

Catch-up vaccination

- Unvaccinated persons should complete a 3-dose series at 0, 1–2, 6 months. See Table 2 for minimum intervals
- 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:
  - **Heplisav-B®:** 2-dose series at least 4 weeks apart
  - **PreHevbrio®:** 3-dose series at 0, 1, and 6 months
  - Combined HepA and HepB vaccine, **Twinrix®:** 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).

Special situations

- Revaccination is not generally recommended for persons with a normal immune status who were vaccinated as infants, children, adolescents, or adults.
- **Post-vaccination serology testing and revaccination** (if anti-HBs < 10mIU/mL) is recommended for certain populations, including:
  - Infants born to HBsAg-positive mothers
  - Persons who are predialysis or on maintenance dialysis
  - Other immunocompromised persons
  - For detailed revaccination recommendations, see www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/hepb.html.

Note: Heplisav-B and PreHevbrio are not recommended in pregnancy due to lack of safety data in pregnant persons

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 when any HPV vaccine series has been completed using the recommended dosing intervals.

Special situations

- **Immunocompromising conditions, including HIV infection:** 3-dose series, even for those who initiate vaccination at age 9 through 14 years.
- **History of sexual abuse or assault:** Start at age 9 years
- **Pregnancy:** Pregnancy testing not needed before vaccination; HPV vaccination not recommended until after pregnancy; no intervention needed if vaccinated while pregnant

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, 2022, 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, 2022
  - 1 dose for **all persons age 9 years or older**
  - For the 2022-2023 season, see www.cdc.gov/mmwr/volumes/71/rr/rr7101a1.htm.
  - For the 2023–24 season, see the 2023–24 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) or required epinephrine or another emergency medical intervention: Any influenza vaccine appropriate for age and health status may be administered. If using egg-based IIV4 or LAIV4, administer in medical setting under supervision of health care provider who can recognize and manage severe allergic reactions.
- **Severe allergic reaction (e.g., anaphylaxis) to a vaccine component or a previous dose of any influenza vaccine:** see Appendix listing contraindications and precautions
- **Close contacts (e.g., caregivers, healthcare personnel) of severely immunosuppressed persons who require a protected environment:** these persons should not receive LAIV4. If LAIV4 is given, they should avoid contact with/caring for such immunosuppressed persons for 7 days after vaccination.

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

Routine vaccination

- 2-dose series at age 12–15 months, age 4–6 years
- MMR or MMRV may be administered

Note: For dose 1 in children age 12–47 months, it is recommended to administer MMR and varicella vaccines separately. MMRV may be used if parents or caregivers express a preference.

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.
- Minimum interval between *MMRV* doses: 3 months

Notes

Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2023

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
- In mumps outbreak settings, for information about additional doses of MMR (including 3rd dose of MMR), see www.cdc.gov/mmwr/volumes/67/wr/mm6701a7.htm

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 age 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 2 months: 4-dose series (additional 3 doses at age 4, 6, and 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 PCV series.
- **MenQuadfi®**
  - Dose 1 at age 24 months or older: 2-dose series at least 8 weeks apart

Travel to 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 2 months: 4-dose series (additional 3 doses at age 4, 6, and 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 component 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.

**Menveo has two formulations: lyophilized and liquid. The liquid formulation should not be used before age 10 years.*

Note: Menactra® should be administered either before or at the same time as DTaP. MenACWY may be administered simultaneously with MenB vaccines if indicated, but at a different anatomic site, if feasible.

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 (if dose 2 was administered at least 6 months after dose 1, dose 3 not needed; if dose 3 is administered earlier than 4 months after dose 2, a 4th dose should be administered at least 4 months after dose 3)

Note: 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.

Notes

Pneumococcal vaccination (minimum age: 6 weeks [PCV13], [PCV15], 2 years [PPSV23])

Routine vaccination with PCV

- 4-dose series at 2, 4, 6, 12–15 months

Catch-up vaccination with PCV

- Healthy children age 24–59 months with any incomplete* PCV series: 1 dose PCV
- For other catch-up guidance, see Table 2.

Note: PCV13 and PCV15 can be used interchangeably for children who are healthy or have underlying conditions. PCV15 is not indicated for children who have received 4 doses of PCV13 or another age appropriate complete PCV13 series.

Special situations

Underlying conditions below: When both PCV and PPSV23 are indicated, administer PCV first. PCV and PPSV23 should not be administered during the 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 PCV doses: 1 dose PCV (at least 8 weeks after any prior PCV dose)
  - Less than 3 PCV doses: 2 doses PCV (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 PCV doses)

Age 6–18 years

- Any incomplete* series with PCV: no further PCV doses needed
- No history of PPSV23: 1 dose PPSV23 (at least 8 weeks after completing all recommended PCV doses)

Cerebrospinal fluid leak, cochlear implant:

Age 2–5 years

- Any incomplete* series with:
  - 3 PCV doses: 1 dose PCV (at least 8 weeks after any prior PCV dose)
  - Less than 3 PCV doses: 2 doses PCV (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 PCV doses)

Age 6–18 years

- No history of either PCV or PPSV23: 1 dose PCV, 1 dose PPSV23 at least 8 weeks later
- Any PCV but no PPSV23: 1 dose PPSV23 at least 8 weeks after the most recent dose of PCV
- PPSV23 but no PCV: 1 dose PCV at least 8 weeks after the most recent dose of PPSV23

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 PCV doses: 1 dose PCV (at least 8 weeks after any prior PCV dose)
  - Less than 3 PCV doses: 2 doses PCV (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 PCV doses) and a dose 2 of PPSV23 5 years later

Age 6–18 years

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

**Incomplete series* = Not having received all doses in either the recommended series or an age-appropriate catch-up series see Table 2 in ACIP pneumococcal recommendations at www.cdc.gov/mmwr/volumes/71/wr/mm7137a3.htm

For guidance on determining which pneumococcal vaccines a patient needs and when, please refer to the mobile app, which can be downloaded here: www.cdc.gov/vaccines/vpd/pneumo/hcp/pneumoapp.html

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.

Special situations

- **Adolescents aged 18 years at increased risk of exposure to poliovirus with:**
  - No evidence of a complete polio vaccination series (i.e., at least 3 doses): administer remaining doses (1, 2, or 3 doses) to complete a 3-dose series
  - Evidence of completed polio vaccination series (i.e., at least 3 doses): may administer one lifetime IPV booster

For detailed information, see: www.cdc.gov/vaccines/vpd/polio/hcp/recommendations.html

Rotavirus vaccination
(minimum age: 6 weeks)

Routine vaccination

- **Rotarix®:** 2-dose series at age 2 and 4 months
- **RotaTeq®:** 3-dose series at age 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 age 12–15 months, 4–6 years
- VAR or MMRV may be administered*
- Dose 2 may be administered as early as 3 months after dose 1 (a dose inadvertently administered after at least 4 weeks may be counted as valid)

**Note:* For dose 1 in children age 12–47 months, it is recommended to administer MMR and varicella vaccines separately. MMRV may be used if parents or caregivers express a preference.

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 inadvertently administered after at least 4 weeks may be counted as valid)
  - **Age 13 years and older**: Routine interval: 4–8 weeks (minimum interval: 4 weeks)
  - The maximum age for use of *MMRV* is 12 years.

Appendix Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2023

Guide to Contraindications and Precautions to Commonly Used Vaccines

Adapted from Table 4-1 in Advisory Committee on Immunization Practices (ACIP) General Best Practice Guidelines for Immunization: Contraindication and Precautions available at www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html *and ACIP's Recommendations for the Prevention and Control of 2022-23 seasonal influenza with Vaccines available at* www.cdc.gov/mmwr/volumes/71/rr/rr7101a1.htm.

For COVID-19 vaccine contraindications and precautions see www.cdc.gov/vaccines/covid-19/clinical-considerations/interim-considerations-us.html#contraindications

Vaccine	Contraindicated or Not Recommended[1]	Precautions[2]
Influenza, egg-based, inactivated injectable (IIV4)	• Severe allergic reaction (e.g., anaphylaxis) after previous dose of any influenza vaccine (i.e., any egg-based IIV, ccIIV, RIV, or LAIV of any valency) • Severe allergic reaction (e.g., anaphylaxis) to any vaccine component[3] (excluding egg)	• Guillain-Barré syndrome (GBS) within 6 weeks after a previous dose of any type of influenza vaccine • Moderate or severe acute illness with or without fever
Influenza, cell culture-based inactivated injectable [(ccIIV4), Flucelvax® Quadrivalent]	• Severe allergic reaction (e.g., anaphylaxis) to any ccIIV of any valency, or to any component[3] of ccIIV4	• Guillain-Barré syndrome (GBS) within 6 weeks after a previous dose of any type of influenza vaccine • Persons with a history of severe allergic reaction (e.g., anaphylaxis) after a previous dose of any egg-based IIV, RIV, or LAIV of any valency. If using ccIV4, administer in medical setting under supervision of health care provider who can recognize and manage severe allergic reactions. May consult an allergist. • Moderate or severe acute illness with or without fever
Influenza, recombinant injectable [(RIV4), Flublok® Quadrivalent]	• Severe allergic reaction (e.g., anaphylaxis) to any RIV of any valency, or to any component[3] of RIV4	• Guillain-Barré syndrome (GBS) within 6 weeks after a previous dose of any type of influenza vaccine • Persons with a history of severe allergic reaction (e.g., anaphylaxis) after a previous dose of any egg-based IIV, ccIIV, or LAIV of any valency. If using RIV4, administer in medical setting under supervision of health care provider who can recognize and manage severe allergic reactions. May consult an allergist. • Moderate or severe acute illness with or without fever
Influenza, live attenuated [LAIV4, Flumist® Quadrivalent]	• Severe allergic reaction (e.g., anaphylaxis) after previous dose of any influenza vaccine (i.e., any egg-based IIV, ccIIV, RIV, or LAIV of any valency) • Severe allergic reaction (e.g., anaphylaxis) to any vaccine component[3] (excluding egg) • Children age 2 –4 years with a history of asthma or wheezing • Anatomic or functional asplenia • Immunocompromised due to any cause including, but not limited to, medications and HIV infection • Close contacts or caregivers of severely immunosuppressed persons who require a protected environment • Pregnancy • Cochlear implant • Active communication between the cerebrospinal fluid (CSF) and the oropharynx, nasopharynx, nose, ear or any other cranial CSF leak • Children and adolescents receiving aspirin or salicylate-containing medications • 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	• Guillain-Barré syndrome (GBS) within 6 weeks after a previous dose of any type of influenza vaccine • Asthma in persons aged 5 years old or older • Persons with underlying medical conditions (other than those listed under contraindications) that might predispose to complications after wild-type influenza virus infection [e.g., chronic pulmonary, cardiovascular (except isolated hypertension), renal, hepatic, neurologic, hematologic, or metabolic disorders (including diabetes mellitus)] • Moderate or severe acute illness with or without fever

1. When a contraindication is present, a vaccine should NOT be administered. Kroger A, Bahta L, Hunter P. ACIP General Best Practice Guidelines for Immunization. www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html
2. When a precaution is present, vaccination should generally be deferred but might be indicated if the benefit of protection from the vaccine outweighs the risk for an adverse reaction. Kroger A, Bahta L, Hunter P. ACIP General Best Practice Guidelines for Immunization. www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html
3. Vaccination providers should check FDA-approved prescribing information for the most complete and updated information, including contraindications, warnings, and precautions. Package inserts for U.S.-licensed vaccines are available at www.fda.gov/vaccines-blood-biologics/approved-products/vaccines-licensed-use-united-states

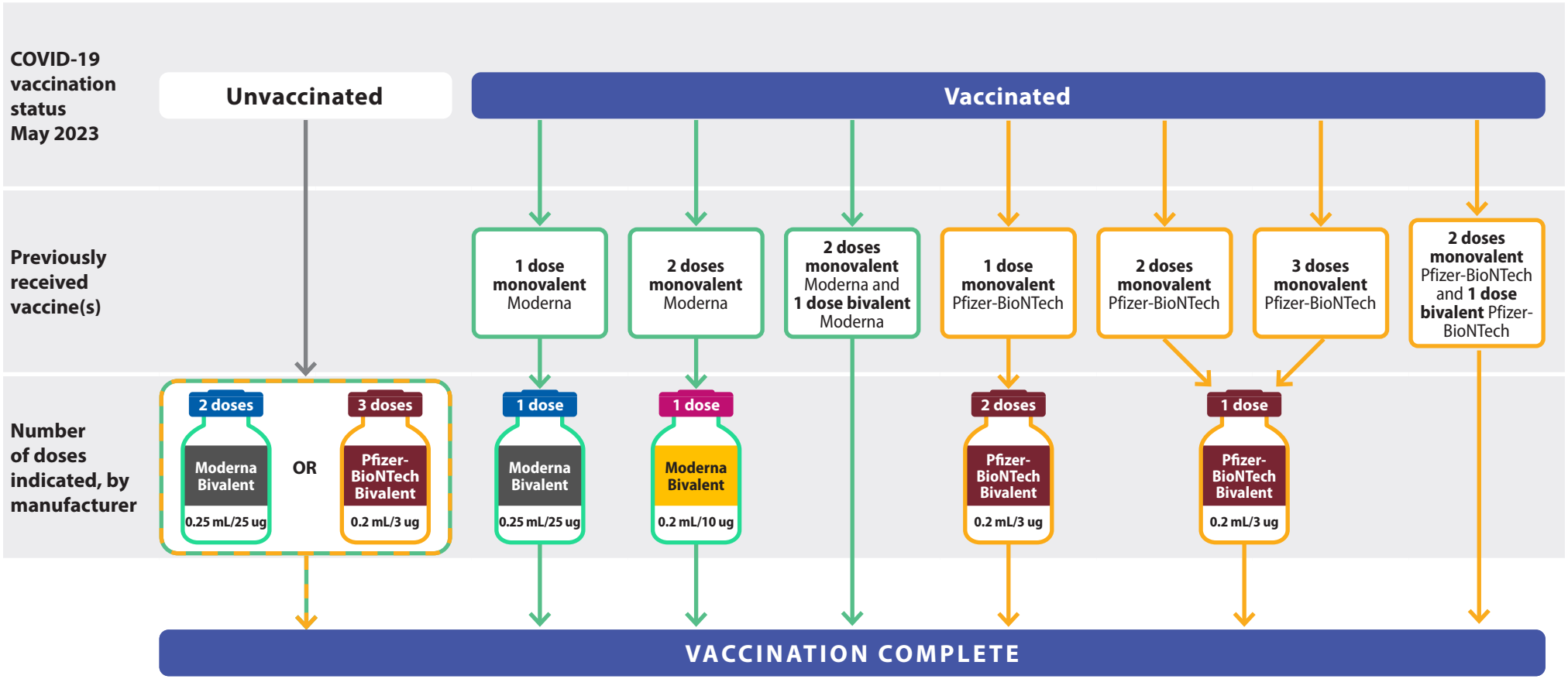
Appendix

Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2023

Vaccine	Contraindicated or Not Recommended[1]	Precautions[2]
Dengue (DEN4CYD)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • Severe immunodeficiency (e.g., hematologic and solid tumors, receipt of chemotherapy, congenital immunodeficiency, long-term immunosuppressive therapy or patients with HIV infection who are severely immunocompromised) • Lack of laboratory confirmation of a previous Dengue infection	• Pregnancy • HIV infection without evidence of severe immunosuppression • Moderate or severe acute illness with or without fever
Diphtheria, tetanus, pertussis (DTaP) Tetanus, diphtheria (DT)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • For DTaP only: Encephalopathy (e.g., coma, decreased level of consciousness, prolonged seizures) not attributable to another identifiable cause within 7 days of administration of previous dose of DTP or DTaP	• Guillain-Barré syndrome (GBS) within 6 weeks after previous dose of tetanus-toxoid–containing vaccine • History of Arthus-type hypersensitivity reactions after a previous dose of diphtheria-toxoid–containing or tetanus-toxoid–containing vaccine; defer vaccination until at least 10 years have elapsed since the last tetanus-toxoid-containing vaccine • For DTaP only: Progressive neurologic disorder, including infantile spasms, uncontrolled epilepsy, progressive encephalopathy; defer DTaP until neurologic status clarified and stabilized • Moderate or severe acute illness with or without fever
Haemophilus influenzae type b (Hib)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • For Hiberix, ActHib, and PedvaxHIB only: History of severe allergic reaction to dry natural latex • Less than age 6 weeks	• Moderate or severe acute illness with or without fever
Hepatitis A (HepA)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] including neomycin	• Moderate or severe acute illness with or without fever
Hepatitis B (HepB)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] including yeast • *Pregnancy: Heplisav-B and PreHevbrio are not recommended due to lack of safety data in pregnant persons. Use other hepatitis B vaccines if HepB is indicated*[4].	• Moderate or severe acute illness with or without fever
Hepatitis A–Hepatitis B vaccine [HepA-HepB, (Twinrix®)]	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] including neomycin and yeast	• Moderate or severe acute illness with or without fever
Human papillomavirus (HPV)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • *Pregnancy: HPV vaccination not recommended.*	• Moderate or severe acute illness with or without fever
Measles, mumps, rubella (MMR) Measles, mumps, rubella, and varicella (MMRV)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • Severe immunodeficiency (e.g., hematologic and solid tumors, receipt of chemotherapy, congenital immunodeficiency, long-term immunosuppressive therapy or patients with HIV infection who are severely immunocompromised) • Pregnancy • Family history of altered immunocompetence, unless verified clinically or by laboratory testing as immunocompetent	• Recent (≤11 months) receipt of antibody-containing blood product (specific interval depends on product) • History of thrombocytopenia or thrombocytopenic purpura • Need for tuberculin skin testing or interferon-gamma release assay (IGRA) testing • Moderate or severe acute illness with or without fever • For MMRV only: Personal or family (i.e., sibling or parent) history of seizures of any etiology
Meningococcal ACWY (MenACWY) [MenACWY-CRM (Menveo®); MenACWY-D (Menactra®); MenACWY-TT (MenQuadfi®)]	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • For MenACWY-D and Men ACWY-CRM only: severe allergic reaction to any diphtheria toxoid– or CRM197–containing vaccine • For MenACWY-TT only: severe allergic reaction to a tetanus toxoid-containing vaccine	• For MenACWY-CRM only: Preterm birth if less than age 9 months • Moderate or severe acute illness with or without fever
Meningococcal B (MenB) [MenB-4C (Bexsero®); MenB-FHbp (Trumenba®)]	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3]	• Pregnancy • For MenB-4C only: Latex sensitivity • Moderate or severe acute illness with or without fever
Pneumococcal conjugate (PCV)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • Severe allergic reaction (e.g., anaphylaxis) to any diphtheria-toxoid-containing vaccine or its component[3]	• Moderate or severe acute illness with or without fever
Pneumococcal polysaccharide (PPSV23)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3]	• Moderate or severe acute illness with or without fever
Poliovirus vaccine, inactivated (IPV)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3]	• Pregnancy • Moderate or severe acute illness with or without fever
Rotavirus (RV) [RV1 (Rotarix®), RV5 (RotaTeq®)]	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • Severe combined immunodeficiency (SCID) • History of intussusception	• Altered immunocompetence other than SCID • Chronic gastrointestinal disease • RV1 only: Spina bifida or bladder exstrophy • Moderate or severe acute illness with or without fever
Tetanus, diphtheria, and acellular pertussis (Tdap) Tetanus, diphtheria (Td)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • For Tdap only: Encephalopathy (e.g., coma, decreased level of consciousness, prolonged seizures) not attributable to another identifiable cause within 7 days of administration of previous dose of DTP, DTaP, or Tdap	• Guillain-Barré syndrome (GBS) within 6 weeks after a previous dose of tetanus-toxoid–containing vaccine • History of Arthus-type hypersensitivity reactions after a previous dose of diphtheria-toxoid–containing or tetanus-toxoid–containing vaccine; defer vaccination until at least 10 years have elapsed since the last tetanus-toxoid–containing vaccine • For Tdap only: Progressive or unstable neurological disorder, uncontrolled seizures, or progressive encephalopathy until a treatment regimen has been established and the condition has stabilized • Moderate or severe acute illness with or without fever
Varicella (VAR)	• Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component[3] • Severe immunodeficiency (e.g., hematologic and solid tumors, receipt of chemotherapy, congenital immunodeficiency, long-term immunosuppressive therapy or patients with HIV infection who are severely immunocompromised) • Pregnancy • Family history of altered immunocompetence, unless verified clinically or by laboratory testing as immunocompetent	• Recent (≤11 months) receipt of antibody-containing blood product (specific interval depends on product) • Receipt of specific antiviral drugs (acyclovir, famciclovir, or valacyclovir) 24 hours before vaccination (avoid use of these antiviral drugs for 14 days after vaccination) • Use of aspirin or aspirin-containing products • Moderate or severe acute illness with or without fever • If using MMRV, see MMR/MMRV for additional precautions

1. When a contraindication is present, a vaccine should NOT be administered. Kroger A, Bahta L, Hunter P. ACIP General Best Practice Guidelines for Immunization. www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html
2. When a precaution is present, vaccination should generally be deferred but might be indicated if the benefit of protection from the vaccine outweighs the risk for an adverse reaction. Kroger A, Bahta L, Hunter P. ACIP General Best Practice Guidelines for Immunization. www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html
3. Vaccination providers should check FDA-approved prescribing information for the most complete and updated information, including contraindications, warnings, and precautions. Package inserts for U.S.-licensed vaccines are available at www.fda.gov/vaccines-blood-biologics/approved-products/vaccines-licensed-use-united-states.
4. For information on the pregnancy exposure registries for persons who were inadvertently vaccinated with Heplisav-B or PreHevbrio while pregnant, please visit heplisavbpregnancyregistry.com/ or www.prehevbrio.com/#safety.

Recommended COVID-19 vaccines for **people without immunocompromise, aged 6 months–4 years**, mRNA vaccines, *with vial icons and dosages*, May 2023*†



*For administration intervals, see Table 1 in the Interim Clinical Considerations for Use of COVID-19 Vaccines.
†Children who receive the Pfizer-BioNTech COVID-19 Vaccine and transition from age 4 years to 5 years during the 3-dose vaccination series must complete the series they start (i.e., receive the 0.2 mL/3 ug dosage supplied in vials with a maroon cap and label with a maroon border for all 3 doses).

Key

Moderna | Pfizer-BioNTech | Moderna **OR** Pfizer-BioNTech

Recommended COVID-19 vaccines for **people without immunocompromise, aged 5 years,** mRNA vaccines, *with vial icons and dosages*, May 2023*†

COVID-19 vaccination status May 2023

Unvaccinated

Vaccinated

Previously received vaccine(s)

- **1 dose monovalent** Moderna
- **2 doses monovalent** Moderna
- **1 or more doses monovalent** Pfizer-BioNTech
- **2 doses monovalent** Moderna and **1 dose bivalent** mRNA
- **Any doses monovalent** Pfizer-BioNTech and **1 dose bivalent** Pfizer-BioNTech

Number of doses indicated, by manufacturer

- **2 doses** Moderna Bivalent 0.25 mL/25 ug **OR** **1 dose** Pfizer-BioNTech Bivalent 0.2 mL/10 ug
- **1 dose** Moderna Bivalent 0.25 mL/25 ug **OR** **1 dose** Pfizer-BioNTech Bivalent 0.2 mL/10 ug
- **1 dose** Moderna Bivalent 0.2 mL/10 ug **OR** **1 dose** Pfizer-BioNTech Bivalent 0.2 mL/10 ug
- **1 dose** Pfizer-BioNTech Bivalent 0.2 mL/10 ug

VACCINATION COMPLETE

*For administration intervals, see Table 1 in the Interim Clinical Considerations for Use of COVID-19 Vaccines.

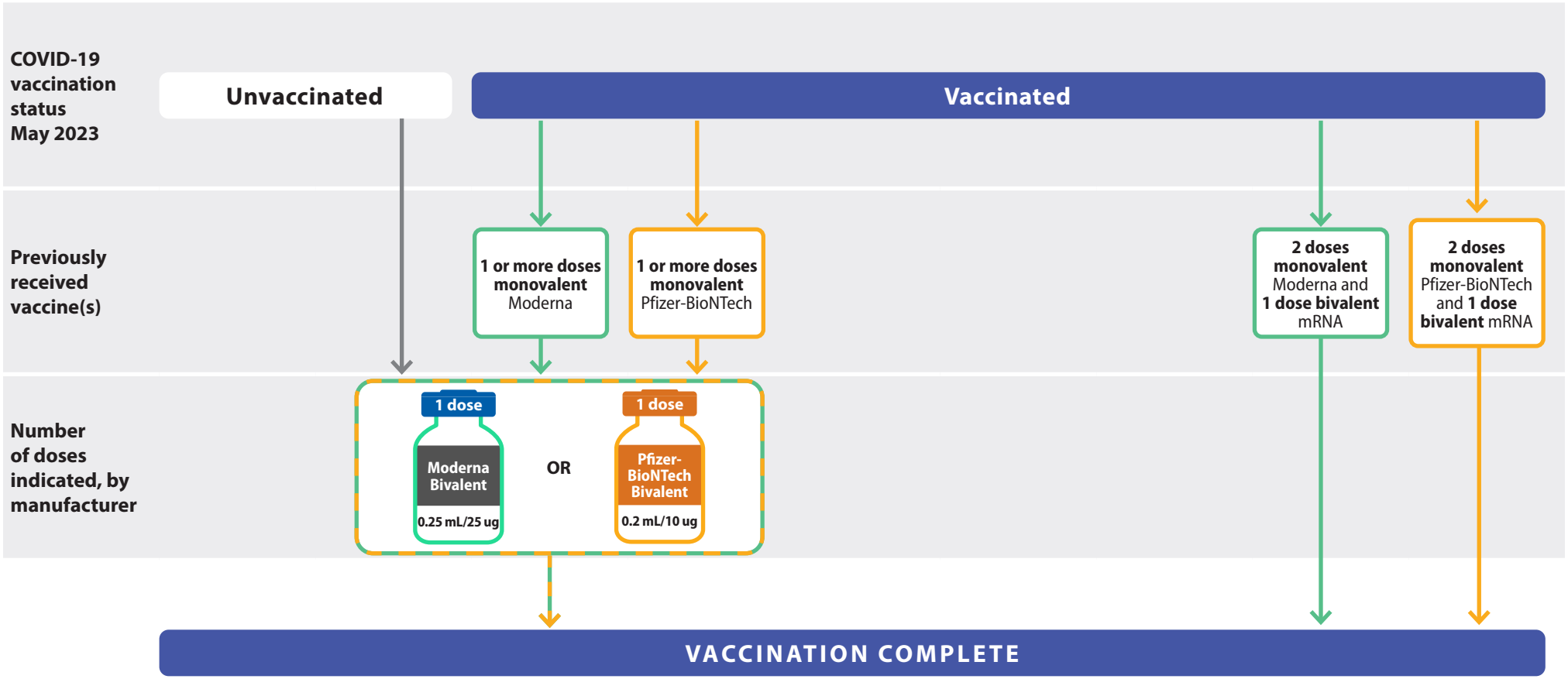
†Children who receive the Pfizer-BioNTech COVID-19 Vaccine and transition from age 4 years to 5 years during the 3-dose vaccination series must complete the series they start (i.e., receive the 0.2 mL/3 ug dosage supplied in vials with a maroon cap and label with a maroon border for all 3 doses).

Children who transition from age 5 years to 6 years during the Moderna vaccination series should receive 2 doses of Moderna COVID-19 Vaccine (0.25 mL/25 ug; dark blue cap and label with a gray border).

Key

Moderna | Pfizer-BioNTech | Moderna **OR** Pfizer-BioNTech

Recommended COVID-19 vaccines for **people without immunocompromise, aged 6–11 years,** mRNA vaccines, *with vial icons and dosages,* May 2023*†

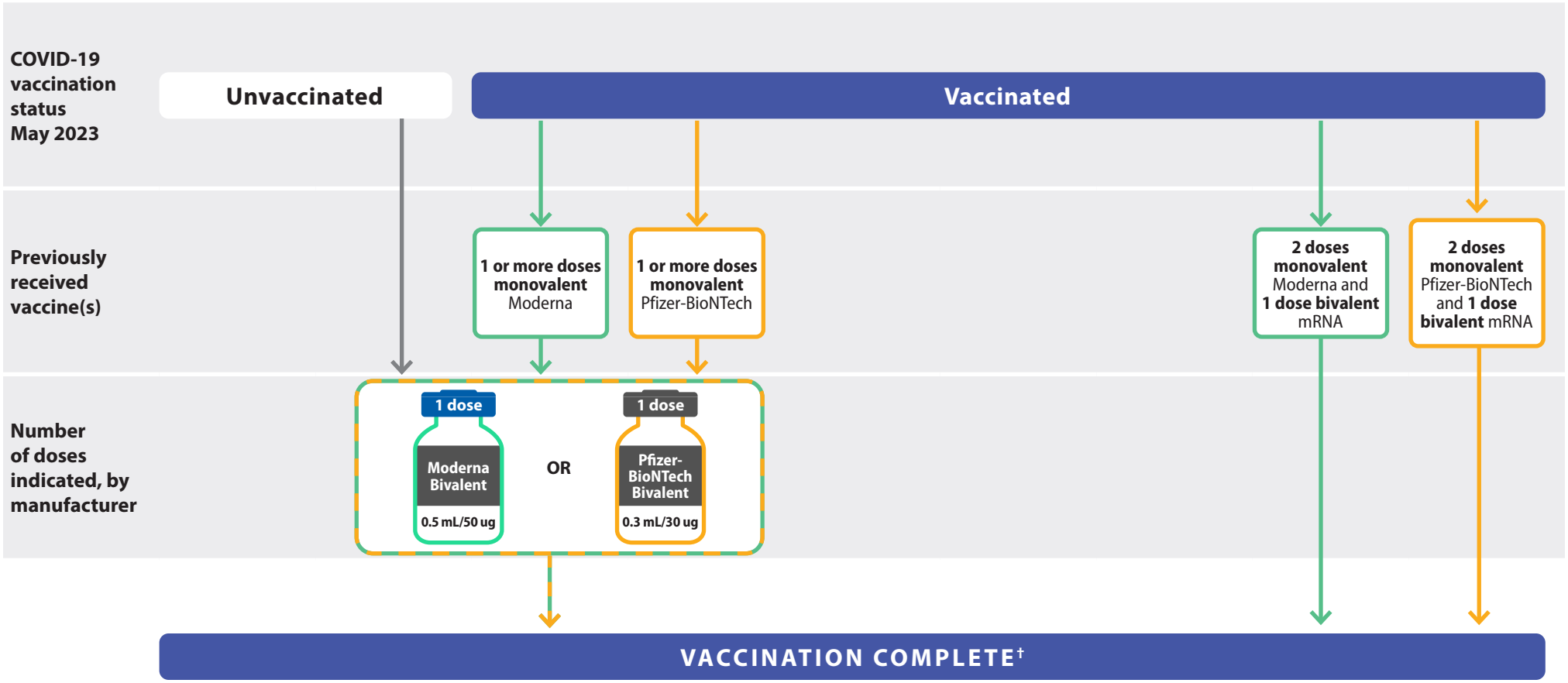


*For administration intervals, see Table 1 in the Interim Clinical Considerations for Use of COVID-19 Vaccines.
†Children who transition from age 5 years to 6 years during the Moderna vaccination series should receive 2 doses of Moderna COVID-19 Vaccine (0.25 mL/25 ug; dark blue cap and label with a gray border).

Key

Moderna | Pfizer-BioNTech | Moderna **OR** Pfizer-BioNTech

Recommended COVID-19 vaccines for **people without immunocompromise, aged 12 years and older,** mRNA vaccines, *with vial icons and dosages,* May 2023*†

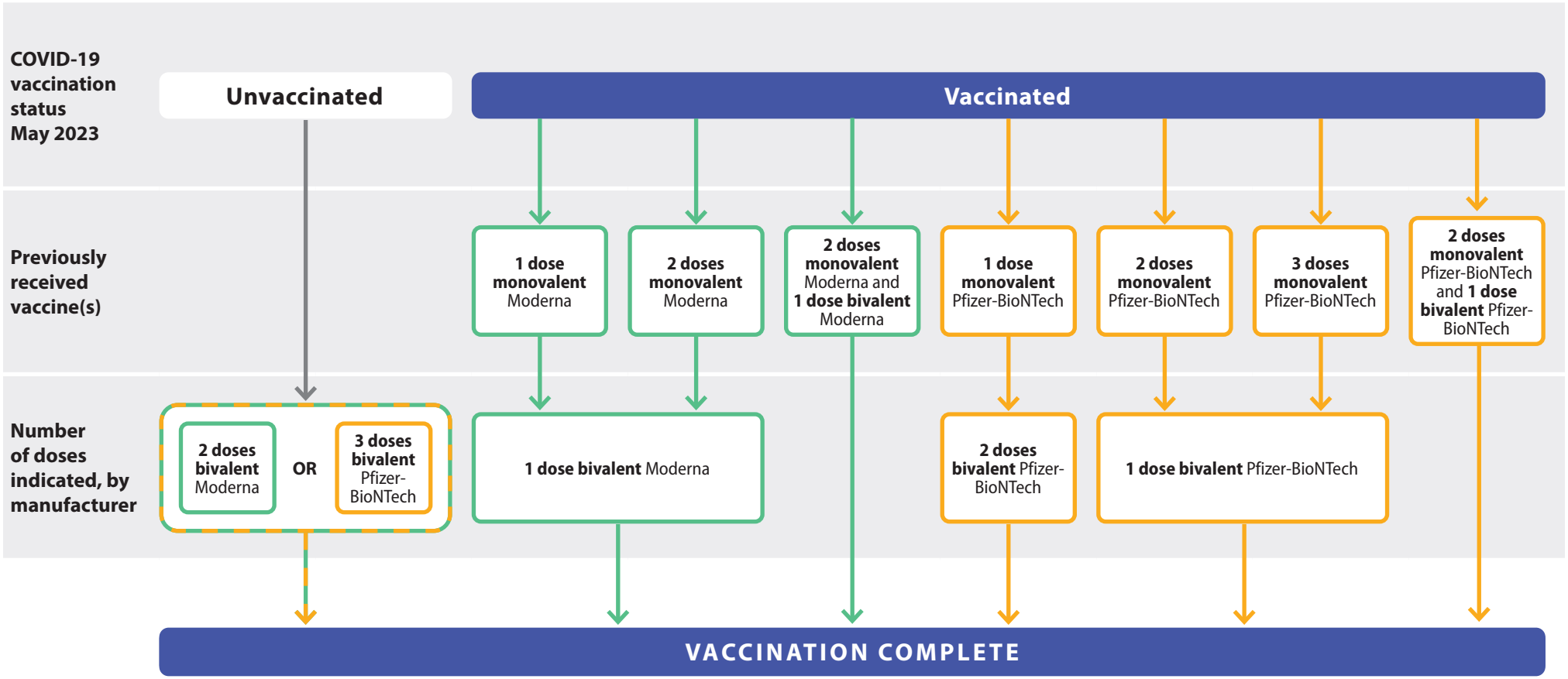


*For administration intervals, see Table 1 in the Interim Clinical Considerations for Use of COVID-19 Vaccines.
†People ages 65 years and older have the option to receive 1 additional bivalent mRNA dose at least 4 months after the first dose of a bivalent mRNA vaccine; see Table 1 in the Interim Clinical Considerations for Use of COVID-19 Vaccines.

Key

Moderna | Pfizer-BioNTech | Moderna **OR** Pfizer-BioNTech

Recommended COVID-19 vaccines for **people without immunocompromise, aged 6 months–4 years**, mRNA vaccines, May 2023*



*For product- and vaccination history-specific dosages and administration intervals, see Table 1 in the Interim Clinical Considerations for Use of COVID-19 Vaccines.

Key

Moderna | Pfizer-BioNTech | Moderna **OR** Pfizer-BioNTech

Recommended COVID-19 vaccines for **people without immunocompromise, aged 5 years,** mRNA vaccines, May 2023*

COVID-19 vaccination status May 2023

Unvaccinated

Vaccinated

Previously received vaccine(s)

- **1 dose monovalent** Moderna
- **2 doses monovalent** Moderna
- **1 or more doses monovalent** Pfizer-BioNTech
- **2 doses monovalent** Moderna and **1 dose bivalent** mRNA
- **Any doses monovalent** Pfizer-BioNTech and **1 dose bivalent** Pfizer-BioNTech

Number of doses indicated, by manufacturer

- **2 doses bivalent** Moderna **OR** **1 dose bivalent** Pfizer-BioNTech
- **1 dose bivalent** Moderna **OR** **1 dose bivalent** Pfizer-BioNTech
- **1 dose bivalent** Pfizer-BioNTech

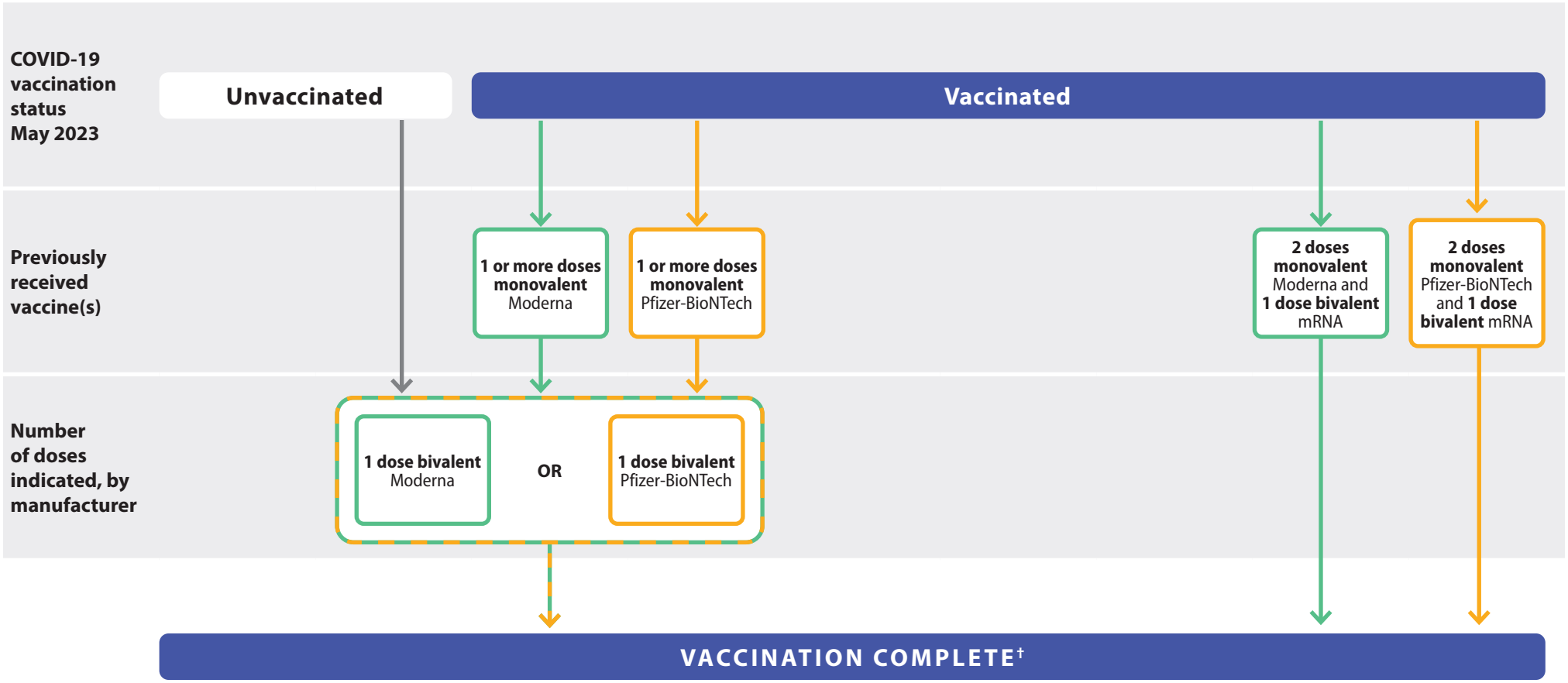
VACCINATION COMPLETE

*For product- and vaccination history-specific dosages and administration intervals, see Table 1 in the Interim Clinical Considerations for Use of COVID-19 Vaccines.

Key

Moderna | Pfizer-BioNTech | Moderna **OR** Pfizer-BioNTech

Recommended COVID-19 vaccines for **people without immunocompromise, aged 6 years and older,** mRNA vaccines, May 2023*



*For product-specific dosages and administration intervals, see Table 1 in the Interim Clinical Considerations for Use of COVID-19 Vaccines.
†People ages 65 years and older have the option to receive 1 additional bivalent mRNA dose at least 4 months after the first dose of a bivalent mRNA vaccine; see Table 1 in the Interim Clinical Considerations for Use of COVID-19 Vaccines.

Key

Moderna | Pfizer-BioNTech | Moderna **OR** Pfizer-BioNTech

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 and COVID-19 vaccination 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, 3 COVID-19	0	1 Influenza, COVID-19
–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 and COVID 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-23 3-5 years later (if <10yrs) or 5 years later (if ≥10 yrs)

- **Meningitis Vaccines**
- **MCV-4:** **Menveo** 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 12 months 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.
- **Serotype B meningococcal vaccine:** **Trumenba** 2 doses, 6 months apart and **Bexero**, 2 doses, 1 month apart intended for pts ≥10yrs with complement deficiency, asplenia, or amidst an outbreak.

Emphasize the importance of recommending the annual Flu shot and COVID-19 vaccination as well.

Case III

You are seeing a 17 yo Anthony for a college physical. He has received DTaP x 5,

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, 3 COVID-19	0	1 Influenza, COVID-19
–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)
* MCV4: 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 bbetween doses 1 and 2, and six months between doses 1 and 3.

Emphasize the importance of recommending the annual Flu shot and COVID-19 vaccination as well.

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.