5. Preventing and Managing Adverse Reactions

Updates

Major changes to the best practice guidance include 1) more descriptive characterization of anaphylactic allergy and 2) incorporation of protocols for managing adverse reactions.

Benefit and Risk Communication

Parents, guardians, legal representatives, and adolescent and adult patients should be informed about the benefits of and risks from vaccines in language that is culturally sensitive and at an appropriate educational level. Opportunity for questions should be provided before each vaccination. Discussion of the benefits of and risks from vaccination is sound medical practice and is required by law.

The National Childhood Vaccine Injury Act of 1986 (1) requires that vaccine information materials be developed for each vaccine covered by the Act (uscode.house.gov). These materials, known as vaccine information statements (VISs), must be provided by all public and private vaccination providers each time a vaccine is administered. Copies of VISs are available from state health authorities responsible for vaccination and from CDC (www.cdc.gov/vaccines/hcp/vis/index.html). Translations of VISs into languages other than English are available from certain state vaccination programs and from the Immunization Action Coalition website (http://www.immunize.org). The act does not require that a signature be obtained; however, documentation of consent might be recommended or required by certain state or local health authorities or school authorities.

Some parents or patients question the need for or safety of vaccinations and want to discuss the risks from and benefits of certain vaccines. Some refuse certain vaccines or reject all vaccinations for personal or religious reasons. Having a basic understanding of how patients and parents of patients view vaccine risk and developing effective approaches to address vaccine safety concerns are imperative for vaccination providers.

Each person understands and reacts to vaccine information on the basis of different factors, including previous experience, education, personal values, method of data
presentation, perceptions of the risk for disease and perceived ability to control these risks, and risk tolerance. In some circumstances, decisions about vaccination are based on inaccurate information about risk provided by the media and certain websites. Websites and other sources of vaccine information may be inaccurate or incomplete. Health care providers can be a pivotal source of science-based credible information by discussing with parents and patients the risks from and benefits of vaccines, which helps patients make informed decisions.

When a parent or patient initiates a discussion about a perceived vaccine adverse reaction, the health care provider should discuss the specific concerns and provide factual information, using appropriate language. Effective, empathetic vaccine risk communication is essential in responding to misinformation and concerns, with health care providers recognizing that risk assessment and decision-making can be difficult and confusing. Certain vaccines might be acceptable to a parent who is resistant to other vaccines. This partial acceptance can be used to facilitate additional communication. Their concerns can be addressed using the VIS and offering other resource materials (e.g., vaccination information from CDC: www.cdc.gov/vaccines/hcp/vis/index.html).

The American Academy of Pediatrics (AAP) does not recommend that providers exclude from their practice patients whose parents or guardians question or refuse vaccination. However, an effective public health strategy is to identify common ground and discuss measures that need to be followed if the decision is to defer vaccination (2). Health care providers should reinforce key points about each vaccine, including safety, and emphasize risks for disease among unvaccinated children. Parents should be advised of state laws regarding entry to schools or child-care facilities, which might require that unvaccinated children be excluded from the facility during outbreaks (www.cdc.gov/vaccines/imz-managers/coverage/schoolvaxview/requirements/index.html). These discussions should be documented in the patient’s medical record, including the refusal to receive certain vaccines (i.e., informed refusal). When a vaccine is refused when first offered the provider should take the opportunity to offer the vaccine again at the next visit.
Preventing Adverse Reactions

Vaccines are intended to produce active immunity to specific antigens. An adverse reaction is an undesirable side effect that occurs after a vaccination. Vaccine adverse reactions are classified as 1) local, 2) systemic, or 3) allergic (additional information is available at https://www.fda.gov/BiologicsBloodVaccines/Vaccines/ApprovedProducts/ucm093833.htm). Local reactions (e.g., redness) are usually the least severe and most frequent. Systemic reactions (e.g., fever) occur less frequently than local reactions, and severe allergic reactions (e.g., anaphylaxis) are the least frequent reactions. Severe adverse reactions are rare (3).

Some of the systemic reactions may be complicated by the onset of syncope. Syncope (vasovagal or vasodepressor reaction) can occur after vaccination and is most common among adolescents and young adults. In 2005, the Vaccine Adverse Event Reporting System (VAERS) began detecting a trend of increasing syncope reports that coincided with the licensure of 3 vaccines for adolescents: human papillomavirus (HPV), MenACWY, and Tdap (4). Of particular concern among adolescents has been the risk for serious secondary injuries, including skull fracture and cerebral hemorrhage. Of 463 VAERS reports of syncope during January 1, 2005, to July 31, 2007, a total of 41 listed syncope with secondary injury with information on the timing after vaccination, and the majority of these syncope reports (76%) occurred among adolescents. Among all age groups, 80% of reported syncope episodes occur within 15 minutes of vaccine administration (additional information is available at www.cdc.gov/vaccinesafety/concerns/fainting.html). Providers should take appropriate measures to prevent injuries if a patient becomes weak or dizzy or loses consciousness. Adolescents and adults should be seated or lying down during vaccination. Vaccine providers, particularly when vaccinating adolescents, should consider observing patients (with patients seated or lying down) for 15 minutes after vaccination to decrease the risk for injury should they faint (4). If syncope develops, patients should be observed until the symptoms resolve.

Although allergic reactions are a common concern for vaccine providers, these reactions are uncommon and anaphylaxis following vaccines is rare, occurring at a rate of approximately one per million doses for many vaccines (5). Epinephrine and equipment
for managing an airway should be available for immediate use (6). The best practice to prevent allergic reactions is to identify individuals at increased risk by obtaining a history of allergy to previous vaccinations and vaccine components that might indicate an underlying hypersensitivity. Acute allergic reactions following vaccinations might be caused by the vaccine antigen, residual animal protein, antimicrobial agents, preservatives, stabilizers, or other vaccine components (7). Components of each vaccine are listed in the respective package insert. An extensive list of vaccine components and their use, as well as the vaccines that contain each component, has been published (8) and also is available from CDC (www.cdc.gov/vaccines/pubs/pinkbook/downloads/appendices/b/excipient-table-2.pdf). Additional information and tables of potential allergens in different vaccines are available at (http://www.vaccinesafety.edu/components-Allergens.htm). The allergens identified in the history can be cross-checked against the allergens identified in package inserts.

**Managing Acute Vaccine Reactions**

Vaccine providers should be familiar with identifying immediate-type allergic reactions, including anaphylaxis, and be competent in treating these events at the time of vaccine administration. Providers should also have a plan in place to contact emergency medical services immediately in the event of a severe acute vaccine reaction.

Allergic reactions can include: local or generalized urticaria (hives) or angioedema; respiratory compromise due to wheezing or swelling of the throat; hypotension; and shock. Immediate-immunoglobulin E (IgE)–mediated (type 1) immune reactions, such as anaphylaxis, usually occur within minutes of parenteral administration and involve specific IgE interactions with discrete antigens (9,10). Rapid recognition and initiation of treatment are required to prevent possible progression to respiratory failure or cardiovascular collapse. It is important to note that urticaria may not be present in all cases of anaphylaxis. For respiratory or cardiovascular symptoms, or other signs or symptoms of anaphylaxis, immediate intramuscular epinephrine is the treatment of choice (11,12). Additional doses of epinephrine as well as other drugs also might be indicated (Tables 5-1 and 5-2) (12). If hypotension is present, the patient should be placed in a recumbent position with the legs elevated. Maintenance of the airway, oxygen administration, and intravenous normal saline might be necessary. After the patient is
stabilized, arrangements should be made for immediate transfer to an emergency facility for additional evaluation and treatment. Because anaphylaxis may recur after patients begin to recover, monitoring in a medical facility for several hours is advised, even after complete resolution of symptoms and signs. Additional information on management of patients with anaphylaxis has been published (9).

**Persons Who Have Had an Allergic Reaction Following a Previous Immunization**

For an individual patient who has experienced an immediate reaction to immunization, it is important to identify the type of reaction that occurred, obtain a history of prior allergic reactions, and try to identify the particular agent responsible. An algorithm approach to these patients has been published (13) and additional advice is available for allergists on the evaluation of these adverse events (10). In general, a history of a severe allergic reaction to a vaccine should be considered a contraindication to additional doses of the same vaccine (13). Referral of the individual to an allergist for evaluation is usually indicated to possibly determine the component responsible, before making decisions regarding administration of the additional doses of the same vaccine or other vaccines that have the same components. Patients who have not had a severe allergic reaction following a vaccine, but who have a history of possible allergy to a vaccine component can often be vaccinated safely after careful evaluation (6).

**Influenza Vaccination of Persons with a History of Egg Allergy**

Severe allergic and anaphylactic reactions can occur in response to a number of influenza vaccine components, but such reactions are rare (6). All but the recombinant inactivated influenza vaccine may have come into contact with egg protein. The use of influenza vaccines for persons with a history of egg allergy has been reviewed recently by ACIP (14). VAERS data mining did not identify a higher than expected proportion of serious allergic events after influenza vaccination during the 2011-2012 season, relative to all other reported vaccines and adverse events in the database. Persons with a history of egg allergy should receive recombinant inactivated vaccine (if 18 years or older), or IIV.

Other measures, such as dividing and administering the vaccine by a 2-step approach and
All vaccines should be administered in settings in which personnel and equipment for rapid recognition and treatment of anaphylaxis are available. ACIP recommends that all vaccination providers be certified in cardiopulmonary resuscitation (CPR), have an office emergency plan, and ensure that all staff are familiar with the plan (6). Some persons who report allergy to egg might not be egg-allergic. Those who are able to eat lightly cooked egg (e.g., scrambled egg) without reaction are unlikely to be allergic.

Egg-allergic persons might tolerate egg in baked products (e.g., bread or cake). Tolerance to egg-containing foods does not exclude the possibility of egg allergy (15). Egg allergy can be confirmed by a consistent medical history of adverse reactions to eggs and egg-containing foods, plus skin and/or blood testing for IgE antibodies to egg proteins. A previous severe allergic reaction to influenza vaccine, regardless of the component suspected to be responsible for the reaction, is a contraindication to future receipt of the vaccine (14).

**Yellow Fever Vaccination of Persons with a History of Egg Allergy**

Yellow fever vaccine contains egg protein. There have been insufficient studies to determine which patients with egg allergy may be able to receive yellow fever vaccine, but there are reports of patients with true egg allergy safely receiving yellow fever vaccine after evaluation by specialists with expertise in the management of allergic reactions (16,17). According to the manufacturer, persons who are able to eat eggs or egg products may receive the vaccine (18). However, potential hypersensitivity reactions might occur in persons with a history of minor reactions to eggs. For egg-sensitive persons, a scratch test or intradermal test can be performed before administering the vaccine to check for reactivity. If a person has a severe egg-sensitivity or has a positive skin test to the vaccine, but the vaccination is recommended because of their travel destination-specific risk, desensitization can be performed under direct supervision of a physician experienced in the management of anaphylaxis.
The desensitization procedure is detailed in the product insert (see yellow fever recommendations at https://www.fda.gov/BiologicsBloodVaccines/Vaccines/ApprovedProducts/ucm094074.htm).

**Vaccines with MMR or Varicella Components and Persons with a History of Egg Allergy**

Varicella vaccine is grown in human diploid cell cultures and can safely be administered to persons with a severe allergy to eggs or egg proteins (19). Measles and mumps vaccine viruses are grown in chick embryo fibroblast tissue culture. However, persons with a severe egg allergy can receive measles- or mumps-containing vaccines in the usual manner because the content of these proteins is extremely low (20). The rare severe allergic reactions after measles- or mumps-containing vaccines or varicella are thought to be caused by other components of the vaccine (e.g., gelatin) (21-24). MMR, MMRV, varicella and other vaccines contain hydrolyzed gelatin as a stabilizer.

**Vaccines and Persons with a History of Allergy to Substances Other than Eggs**

Persons who have had an anaphylactic reaction to gelatin or gelatin-containing products should be evaluated by an allergist prior to receiving gelatin-containing vaccines (6).

Certain vaccines contain trace amounts of antimicrobial agents or other preservatives (e.g., neomycin or thimerosal), although allergies to these are rare. No licensed vaccine contains penicillin or penicillin derivatives.

Most often, neomycin hypersensitivity manifests as contact dermatitis, a delayed-type (cell-mediated) immune response rather than immediate-hypersensitivity (IgE-mediated allergy)–type response (25,26). A history of delayed-type reactions to neomycin is not a contraindication for administration of neomycin-containing vaccines. There has only been 1 reported case of immediate hypersensitivity reaction following a neomycin-containing vaccine (27). Persons who have had anaphylactic reactions to neomycin should be evaluated by an allergist prior to receiving vaccines containing neomycin (6).

Thimerosal, an organic mercurial compound in use since the 1930s, is added to certain
immunobiologics as a preservative. Since mid-2001, vaccines routinely recommended for infants younger than 6 months of age have been manufactured without thimerosal as a preservative (14). Live, attenuated vaccines have never contained thimerosal. Thimerosal-free formulations of inactivated influenza vaccine are available. Inactivated influenza vaccine also is available in formulations with only trace amounts of thimerosal, which remains as a manufacturing residual but is not added at the higher concentration that would be necessary for it to function as a preservative. Thimerosal at a preservative concentration is present in certain other vaccines that can be administered to children (e.g., Td and DT). Information about the thimerosal content of vaccines is available from FDA at https://www.fda.gov/BiologicsBloodVaccines/SafetyAvailability/VaccineSafety/UCM096228.

Reactions to thimerosal have been described as local delayed-type hypersensitivity reactions with only rare reports of immediate reactions (28-31). Thimerosal elicits positive delayed-type hypersensitivity patch tests in 1%-18% of persons tested; however, these tests have no relevance to acute allergic reactions that might occur within minutes or hours after immunization (32,33). The majority of persons do not experience reactions to thimerosal administered as a component of vaccines even when patch or intradermal tests for thimerosal indicate hypersensitivity (31). A local or delayed-type hypersensitivity reaction to thimerosal is not a contraindication to receipt of a vaccine that contains thimerosal (34).

Latex is sap from the rubber tree. Latex contains naturally occurring plant proteins that can be responsible for immediate-type allergic reactions. Latex is processed to form either natural rubber latex products such as gloves or dry, natural rubber products such as syringe plunger tips and vial stoppers. Synthetic rubber is also used in gloves, syringe plungers, and vial stoppers but does not contain the latex proteins linked to immediate-type allergic reactions. Natural rubber latex or dry, natural rubber used in vaccine packaging generally is noted in the manufacturers’ package inserts.

Immediate-type allergic reactions due to latex allergy have been described after vaccination, but such reactions are rare (35).
syringes that contain natural rubber latex should be avoided if possible (6). If not, if the decision is made to vaccinate, providers should be prepared to treat immediate allergic reactions due to latex, including anaphylaxis. The most common type of latex hypersensitivity is a delayed-type (type 4, cell-mediated) allergic contact dermatitis (36). For patients with a history of contact allergy to latex, vaccines supplied in vials or syringes that contain dry natural rubber or natural rubber latex may be administered.

**Reporting Adverse Events After Vaccination**

Modern vaccines are safe and effective; however, adverse events have been reported after administration of all vaccines (3). More complete information about adverse reactions to a specific vaccine is available in the package insert for each vaccine and from CDC at [www.cdc.gov/vaccines/vac-gen/side-effects.htm](http://www.cdc.gov/vaccines/vac-gen/side-effects.htm). An adverse event is an untoward event that occurs after a vaccination that might be caused by the vaccine product or vaccination process. These events range from common, minor, local reactions to rare, severe, allergic reactions (e.g., anaphylaxis). Reporting to VAERS helps establish trends, identify clusters of adverse events, or generate hypotheses. However, establishing evidence for cause and effect on the basis of case reports and case series alone is usually not possible, because health problems that have a temporal association with vaccination do not necessarily indicate causality.

Many adverse events require more detailed epidemiologic studies to compare the incidence of the event among vaccinees with the incidence among unvaccinated persons. Potential causal associations between reported adverse events after vaccination can be assessed through epidemiologic or clinical studies.

The National Childhood Vaccine Injury Act of 1986 (1) requires health care personnel and vaccine manufacturers to report to VAERS specific adverse events that occur after vaccination. The reporting requirements are different for manufacturers and health care personnel. Manufacturers are required to report all adverse events that occur after vaccination to VAERS, whereas health-care providers are required to report events that appear in the reportable events table on the VAERS website at [https://vaers.hhs.gov/docs/VAERS_Table_of_Reportable_Events_Following_Vaccination.pdf](https://vaers.hhs.gov/docs/VAERS_Table_of_Reportable_Events_Following_Vaccination.pdf).
In addition to the mandated reporting of events listed on the reportable events table, health care personnel should report to VAERS all events listed in product inserts as contraindications, as well as all clinically significant adverse events, even if they are uncertain that the adverse event is related causally to vaccination (6). Persons other than health care personnel also can report adverse events to VAERS.

General information on VAERS is available at https://vaers.hhs.gov/index.html. Specific information for healthcare providers is available at https://vaers.hhs.gov/resources/infoproviders.html. Reporting to VAERS is fully electronic and can be done using an online reporting tool or a writable PDF; instructions are available at https://vaers.hhs.gov/reportevent.html. Further assistance on VAERS reporting is available through email at info@VAERS.org and the VAERS toll free number 1-800-822-7967.

**National Vaccine Injury Compensation Program**

The National Vaccine Injury Compensation Program, established by the National Childhood Vaccine Injury Act of 1986 (1), is a no-fault system in which persons thought to have experienced an injury or to have died as a result of administration of a covered vaccine can seek compensation. The program became operational on October 1, 1988, and is intended as an alternative to civil litigation under the traditional tort system in that negligence need not be proven. Claims arising from covered vaccines must first be adjudicated through the program before civil litigation can be pursued.

The program relies on the Vaccine Injury Table, which lists the vaccines covered by the program and the injuries (including death), disabilities, illnesses, and conditions for which compensation might be awarded. The table defines the time during which the first symptom or substantial aggravation of an injury must appear after vaccination to be eligible. Successful claimants receive a legal presumption of causation if a condition listed in the table is proven, thus avoiding the need to prove actual causation in an individual case. Claimants also can prevail for conditions not listed in the reportable events table if they prove causation for covered vaccines. Additional information is available from the Health Resources and Services Administration (HRSA at https://www.hrsa.gov/vaccine-
compensation/index.html or by telephone at 800-338-2382). Persons who would like to file a claim for vaccine injury should contact the U.S. Court of Federal Claims (717 Madison Place, N.W., Washington, DC 20005; telephone: 202-357-6400).
### TABLE 5-1: Rapid overview: Emergent management of anaphylaxis in infants and children\(^{(a)}\)

<table>
<thead>
<tr>
<th>Diagnosis is made clinically:</th>
<th>The most common signs and symptoms are cutaneous (e.g., sudden onset of generalized urticaria, angioedema, flushing, pruritus). However, 10 to 20% of patients have no skin findings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danger signs: Rapid progression of symptoms, evidence of respiratory distress (e.g., stridor, wheezing, dyspnea, increased work of breathing, retractions, persistent cough, cyanosis), signs of poor perfusion, abdominal pain, vomiting, dysrhythmia, hypotension, collapse.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acute management:</th>
<th>The first and most important therapy in anaphylaxis is epinephrine. There are NO absolute contraindications to epinephrine in the setting of anaphylaxis.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway: Immediate intubation if evidence of impending airway obstruction from angioedema. Delay may lead to complete obstruction. Intubation can be difficult and should be performed by the most experienced clinician available. Cricothyrotomy may be necessary.</td>
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</tr>
<tr>
<td>IM epinephrine (1 mg/mL preparation): Epinephrine 0.01 mg/kg should be injected intramuscularly in the midouter thigh. For large children (&gt;50 kg), the maximum is 0.5 mg per dose. If there is no response or the response is inadequate, the injection can be repeated in 5 to 15 minutes (or more frequently). If epinephrine is injected promptly IM, patients respond to one, two, or at most, three injections. If signs of poor perfusion are present or symptoms are not responding to epinephrine injections, prepare IV epinephrine for infusion (see below).</td>
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<tr>
<td>Place patient in recumbent position, if tolerated, and elevate lower extremities.</td>
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<tr>
<td>Oxygen: Give 8 to 10 L/minute via facemask or up to 100% oxygen, as needed.</td>
<td></td>
</tr>
<tr>
<td>Normal saline rapid bolus: Treat poor perfusion with rapid infusion of 20 mL/kg. Reevaluate and repeat fluid boluses (20 mL/kg), as needed. Massive fluid shifts with severe loss of intravascular volume can occur. Monitor urine output.</td>
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</tr>
<tr>
<td>Albuterol: For bronchospasm resistant to IM epinephrine, give albuterol 0.15 mg/kg (minimum dose: 2.5 mg) in 3 mL saline inhaled via nebulizer. Repeat, as needed.</td>
<td></td>
</tr>
<tr>
<td>H1 antihistamine: Consider giving diphenhydramine 1 mg/kg (max 40 mg) IV given over 5 minutes, or cetirizine (children age 6 months to 5 years can receive 2.5 mg IV, those 6 to 11 years of age can receive 5 or 10 mg IV, over 2 minutes).</td>
<td></td>
</tr>
<tr>
<td>H2 antihistamine: Consider giving famotidine 0.25 mg/kg (max 20 mg) IV, over at least 2 minutes.</td>
<td></td>
</tr>
<tr>
<td>Glucocorticoid: Consider giving methylprednisolone 1 mg/kg (max 125 mg) IV.</td>
<td></td>
</tr>
<tr>
<td>Monitoring: Continuous noninvasive hemodynamic monitoring and pulse oximetry monitoring should be performed. Urine output should be monitored in patients receiving IV fluid resuscitation for severe hypotension or shock.</td>
<td></td>
</tr>
<tr>
<td>Treatment of refractory symptoms:</td>
<td>Epinephrine infusion(^{(b)}): In patients with inadequate response to IM epinephrine and IV saline, give epinephrine continuous infusion at 0.1 to 1 mcg/kg/minute, titrated to effect.</td>
</tr>
<tr>
<td>Vasopressors(^{(b)}): Patients may require large amounts of IV crystalloid to maintain blood pressure. Some patients may require a second vasopressor (in addition to epinephrine). All vasopressors should be given by infusion pump, with the doses titrated continuously according to blood pressure and cardiac rate/function monitored continuously and oxygenation monitored by pulse oximetry.</td>
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</tbody>
</table>

\(^{(a)}\) A child is defined as a prepubertal patient weighing less than 40 kg.  
\(^{(b)}\) All patients receiving an infusion of epinephrine and/or another vasopressor require continuous noninvasive monitoring of blood pressure, heart rate and function, and oxygen saturation. We suggest that pediatric centers provide instructions for preparation of standard concentrations and also provide charts for established infusion rate for epinephrine and other vasopressors in infants and children.

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Source: (37).
**Table 5-2: Rapid overview: Emergency management of anaphylaxis in adults**

<table>
<thead>
<tr>
<th>Diagnosis is made clinically:</th>
<th>The most common signs and symptoms are cutaneous (e.g., sudden onset of generalized urticaria, angioedema, flushing, pruritus). However, 10 to 20% of patients have no skin findings.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Danger signs:</strong> Rapid progression of symptoms, respiratory distress (e.g., stridor, wheezing, dyspnea, increased work of breathing, persistent cough, cyanosis), vomiting, abdominal pain, hypotension, dysrhythmia, chest pain, collapse.</td>
</tr>
<tr>
<td>Acute management:</td>
<td>The first and most important treatment in anaphylaxis is epinephrine. There are NO absolute contraindications to epinephrine in the setting of anaphylaxis.</td>
</tr>
<tr>
<td></td>
<td><strong>Airway:</strong> Immediate intubation if evidence of impending airway obstruction from angioedema. Delay may lead to complete obstruction. Intubation can be difficult and should be performed by the most experienced clinician available. Cricothyrotomy may be necessary.</td>
</tr>
<tr>
<td>Promptly and simultaneously, give:</td>
<td>IM epinephrine (1 mg/mL preparation): Give epinephrine 0.3 to 0.5 mg intramuscularly, preferably in the midouter thigh. Can repeat every 5 to 15 minutes (or more frequently), as needed. If epinephrine is injected promptly IM, most patients respond to one, two, or at most, three doses. If symptoms are not responding to epinephrine injections, prepare IV epinephrine for infusion (see below).</td>
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<tr>
<td></td>
<td><strong>Place patient in recumbent position, if tolerated, and elevate lower extremities.</strong></td>
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<td></td>
<td><strong>Oxygen:</strong> Give 8 to 10 L/minute via facemask or up to 100% oxygen, as needed.</td>
</tr>
<tr>
<td></td>
<td><strong>Normal saline rapid bolus:</strong> Treat hypotension with rapid infusion of 1 to 2 liters IV. Repeat, as needed. Massive fluid shifts with severe loss of intravascular volume can occur.</td>
</tr>
<tr>
<td></td>
<td><strong>Albuterol (salbutamol):</strong> For bronchospasm resistant to IM epinephrine, give 2.5 to 5 mg in 3 mL saline via nebulizer. Repeat, as needed.</td>
</tr>
<tr>
<td>Adjunctive therapies:</td>
<td><strong>H1 antihistamine:</strong>(a) Consider giving cetirizine 10 mg IV (given over 2 minutes) diphenhydramine 25 to 50 mg IV (given over 5 minutes) (for relief of urticaria and itching only)</td>
</tr>
<tr>
<td></td>
<td><strong>H2 antihistamine:</strong>(a) Consider giving famotidine 20 mg IV (given over 2 minutes).</td>
</tr>
<tr>
<td></td>
<td><strong>Glucocorticoid:</strong>(a) Consider giving methylprednisolone 125 mg IV.</td>
</tr>
<tr>
<td></td>
<td><strong>Monitoring:</strong> Continuous noninvasive hemodynamic monitoring and pulse oximetry monitoring should be performed. Urine output should be monitored in patients receiving IV fluid resuscitation for severe hypotension or shock.</td>
</tr>
<tr>
<td>Treatment of refractory symptoms:</td>
<td>Epinephrine infusion(b): For patients with inadequate response to IM epinephrine and IV saline, give epinephrine continuous infusion, beginning at 0.1 mcg/kg/minute by infusion pump(c). Titrate the dose continuously according to blood pressure, cardiac rate and function, and oxygenation.</td>
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<tr>
<td></td>
<td><strong>Vasopressors:</strong> Some patients may require a second vasopressor (in addition to epinephrine). All vasopressors should be given by infusion pump, with the doses titrated continuously according to blood pressure and cardiac rate/function and oxygenation monitored by pulse oximetry.</td>
</tr>
</tbody>
</table>
Glucagon: Patients on beta blockers may not respond to epinephrine and can be given glucagon 1 to 5 mg IV over 5 minutes, followed by infusion of 5 to 15 mcg/minute. Rapid administration of glucagon can cause vomiting.

Instructions on how to prepare and administer epinephrine for IV continuous infusions are available as separate tables in UpToDate.

IM: intramuscular; IV: intravenous.

(a) These medications should not be used as initial or sole treatment.

(b) All patients receiving an infusion of epinephrine and another vasopressor require continuous noninvasive monitoring of blood pressure, heart rate and function, and oxygen saturation.

(c) For example, the initial infusion rate for a 70 kg patient would be 7 mcg/minute. This is consistent with the recommended range for non–weight-based dosing for adults, which is 2 to 10 mcg/minute. Non–weight-based dosing can be used if the patient’s weight is not known and cannot be estimated.

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Source: (37).
REFERENCES


6. Vaccine Administration

Infection Control and Sterile Technique

General Precautions

Persons administering vaccinations should follow appropriate precautions to minimize risk for disease exposure and spread. Hands should be cleansed with an alcohol-based waterless antiseptic hand rub or washed with soap and water before preparing vaccines for administration and between each patient contact (1). Occupational Safety and Health Administration (OSHA) regulations do not require gloves to be worn when administering vaccinations, unless persons administering vaccinations have open lesions on their hands or are likely to come into contact with a patient’s body fluids (2). If worn, gloves should be changed between patients.

Vaccine Administration: Preparation and Timely Disposal

Vaccines should be drawn up in a designated clean medication area that is not adjacent to areas where potentially contaminated items are placed. Multi-dose vials to be used for more than one patient should not be kept or accessed in the immediate patient treatment area. This is to prevent inadvertent contamination of the vial through direct or indirect contact with potentially contaminated surfaces or equipment that could then lead to infections in subsequent patients (3). Smallpox vaccine is accessed by dipping a bifurcated needle directly into the vaccine vial. The vaccine adheres to the sides of the bifurcated needle, and is administered via skin puncture. The vial must be accessed in the immediate patient area to reduce environmental contamination by vaccine virus. To prevent contamination of the vial, make sure the patient area is clean and free of potentially contaminated equipment.

Different single-components of combination vaccines should never be mixed in the same syringe by an end-user unless specifically licensed for such use (4). Single-dose vials and manufacturer-filled syringes are designed for single-dose administration and should be discarded if vaccine has been withdrawn or reconstituted and subsequently not used within the time frame specified by the manufacturer. Syringes that are prefilled by the manufacturer and activated (i.e., syringe cap removed or needle attached) but unused should be discarded at the end of the clinic day. For inactivated vaccines manufacturers,
typically recommend use within the same day that a vaccine is withdrawn or reconstituted. For live vaccines that require reconstitution, manufacturers typically recommend the vaccine be used as soon as possible after reconstitution and be discarded if not used within 30 minutes after reconstitution. For example, varicella vaccine should be discarded if not used within 30 minutes after reconstitution, whereas MMR vaccine, once reconstituted, must be kept in a dark place at 36°F to 46°F (2°C to 8°C) and should be discarded within 8 hours if not used. When in doubt about the appropriate handling of a vaccine, vaccination providers should contact that vaccine’s manufacturer.

ACIP discourages the routine practice of providers’ prefilling syringes for several reasons. Because the majority of vaccines have a similar appearance after being drawn into a syringe, prefilling might result in administration errors. Because unused prefilled syringes also typically must be discarded if not used within the same day that they are filled, vaccine wastage might occur. The FDA does not license administration syringes for vaccine storage.

In certain circumstances in which a single vaccine type is being used (e.g., in preparation for a community influenza vaccination campaign), filling a small number (10 or fewer) of syringes may be considered (5). The doses should be administered as soon as possible after filling, by the same person who filled the syringes. Unused syringes that are prefilled by the manufacturer and activated (i.e., syringe cap removed or needle attached) should be discarded at the end of the clinic day. Vaccine from two or more vials should never be combined to make one or more doses. This can lead to violation of expiration dates and product contamination (6,7).

**Health Care Provider Exposure to Vaccine Components**

Providers are sometimes concerned when they have the same contraindications or precautions as their patients from whom they withhold or defer vaccine. For administration of routinely recommended vaccines, there is no evidence of risk of exposure of vaccine components to the health care provider, so conditions in the provider labeled as contraindications and precautions to a vaccine components are not a reason to withdraw from this function of administering the vaccine to someone else. Historic concerns about exposure to vaccine components are limited to non-parenteral vaccines in which some degree of environmental exposure is unavoidable (5, 8), or situations in which
self-inoculation is likely due to the nature of the vaccine microbe [e.g. reduced attenuation of smallpox vaccine virus (9)]. Persons administering ACAM 2000 smallpox vaccine to laboratory and health care personnel at risk for occupational exposure to orthopoxviruses can decrease the risk for inadvertent infection through recommended infection prevention measures. However, because of a theoretical risk for infection, vaccination with ACAM2000 can be offered to health care personnel administering this vaccine, provided individual persons have no specified contraindications to vaccination (10).

Safe Use of Needles and Syringes

Needles and syringes used for vaccine injections must be sterile and disposable. A separate needle and syringe should be used for each injection. Changing needles between drawing vaccine from a vial and injecting it into a recipient is not necessary unless the needle has been damaged or contaminated (11).

Bloodborne diseases (e.g., hepatitis B, hepatitis C, human immunodeficiency virus [HIV]) are occupational hazards for clinicians and other health-care providers. The Needlestick Safety and Prevention Act (2) was enacted in 2000 to reduce the incidence of needlestick injury and the consequent risk for bloodborne diseases acquired from patients. The act directed OSHA to strengthen its existing bloodborne pathogen standards. The revised standards became effective in 2001 (2). These federal regulations require the use of engineering and work practice controls to eliminate or minimize employee exposure to bloodborne pathogens. Engineering controls means controls (e.g., sharps disposal containers, self-sheathing needles, safer medical devices, such as sharps with engineered sharps injury protections and needleless systems) that isolate or remove the bloodborne pathogens hazard from the workplace). Needle-shielding or needle-free devices that might satisfy the occupational safety regulations for administering injectable vaccines are available in the United States (12-13). The regulations also require maintenance of records documenting injuries caused by needles and other medical sharp objects and that nonmanagerial employees be involved in the evaluation and selection of safety-engineered devices before they are procured. Additional information about implementation and enforcement of these regulations is available from OSHA.

To prevent inadvertent needlestick injury or reuse, safety mechanisms should be deployed after use and needles and syringes should be discarded immediately in labeled, puncture-
proof containers located in the same room where the vaccine is administered (5). Used needles should never be recapped.

**Route of Administration**

**Injectable Route**

Routes of administration are recommended by the manufacturer for each immunobiologic (Table 6-1). With the exceptions of bacille Calmette-Guérin (BCG) vaccine and smallpox vaccine (administered intraepidermally), injectable vaccines are administered by the intramuscular or subcutaneous route. Deviation from the recommended route of administration might reduce vaccine efficacy (14-15) or increase the risk for local adverse reactions (16-18).

The method of administration of injectable vaccines is determined, in part, by the inclusion of adjuvants in some vaccines. An adjuvant is a vaccine component distinct from the antigen that enhances the immune response to the antigen, but might also increase risk of adverse reactions. To decrease risk of local adverse events, inactivated vaccines containing an adjuvant should be injected into a muscle. Administering a vaccine containing an adjuvant either subcutaneously or intradermally can cause local irritation, induration, skin discoloration, inflammation, and granuloma formation.

**Intramuscular Injections**

**Needle Length**

Injectable immunobiologics should be administered where local, neural, vascular, or tissue injury is unlikely. Use of longer needles has been associated with less redness or swelling than occurs with shorter needles because of injection into deeper muscle mass (16). Appropriate needle length depends on age and body mass. Injection technique is the most important parameter to ensure efficient intramuscular vaccine delivery.

For all intramuscular injections, the needle should be long enough to reach the muscle mass and prevent vaccine from seeping into subcutaneous tissue, but not so long as to involve underlying nerves, blood vessels, or bone (15,19-22). Vaccinators should be familiar with the anatomy of the area into which they are injecting vaccine. Intramuscular injections are administered at a 90-degree angle to the skin, preferably into the anterolateral aspect of the thigh or the deltoid muscle of the upper arm, depending on the age of the patient (Table 6-2).
The needle gauge for intramuscular injection is 22-25 gauge. A decision on needle length and site of injection must be made for each person on the basis of the size of the muscle, the thickness of adipose tissue at the injection site, the volume of the material to be administered, injection technique, and the depth below the muscle surface into which the material is to be injected (Figure 1). Some experts allow intramuscular injection with a $\frac{5}{8}$-inch needle but ONLY if the skin is stretched flat (21). If the subcutaneous and muscle tissue are bunched to minimize the chance of striking bone (19), a 1-inch needle or larger is required to ensure intramuscular administration. Aspiration before injection of vaccines or toxoids (i.e., pulling back on the syringe plunger after needle insertion but before injection) is not necessary because no large blood vessels are present at the recommended injection sites, and a process that includes aspiration might be more painful for infants (22).

**Infants (Aged <12 Months)**
For the majority of infants, the anterolateral aspect of the thigh is the recommended site for injection because it provides comparatively larger muscle mass than the deltoid (Figure 2) (23). In certain circumstances (e.g., physical obstruction to other sites and no reasonable indication to defer doses), the gluteal muscle can be used. If the gluteal muscle must be used, care should be taken to define the anatomic landmarks. For the majority of infants, a 1-inch needle is sufficient to penetrate the thigh muscle.

**Toddlers (Aged 12 Months-2 Years)**
For toddlers, the anterolateral thigh muscle is preferred, and when this site is used, the needle should be at least 1 inch long. The deltoid muscle can be used if the muscle mass is adequate. If 2 vaccines are to be administered in a single limb, they should be spaced an inch apart (4, 24).

**Children (Aged 3-10 Years)**
The deltoid muscle is preferred for children aged 3-10 years (23); the needle length for deltoid site injections can range from $\frac{5}{8}$ to 1 inch on the basis of technique. The anterolateral thigh can also be used (25). In this case the needle length should be 1 inch to 1.25 inches. Knowledge of body mass can be useful for estimating the appropriate needle length (26).

**Young Adolescents (Aged 11-18 years)**
The deltoid muscle is preferred for adolescents 11-18 years of age. The anterolateral thigh can also be used. For injection into the anterolateral thigh, most adolescents will require a 1-1.5-inch needle to ensure intramuscular administration (26).
**Adults (Aged ≥19 Years)**

For adults, the deltoid muscle is recommended for routine intramuscular vaccinations (23) (Figure 3). The anterolateral thigh also can be used. For adults a measurement of body mass/weight is allowable prior to vaccination, understanding that resources to measure body mass/weight are not available in all clinical settings. For men and women who weigh <130 lbs (<60 kg), a ⅝-inch needle is sufficient to ensure intramuscular injection in the deltoid muscle if the injection is made at a 90-degree angle and the tissue is not bunched. For men and women who weigh 130-152 lbs (60-70 kg), a 1-inch needle is sufficient. For women who weigh 152-200 lbs (70-90 kg) and men who weigh 152-260 lbs (70-118 kg), a 1- to 1.5-inch needle is recommended. For women who weigh >200 lbs (>90 kg) or men who weigh >260 lbs (>118 kg), a 1.5-inch needle is recommended (table 6-2) (20).

**Subcutaneous Injections**

Subcutaneous injections are administered at a 45-degree angle, usually into the thigh for infants aged <12 months and in the upper-outer triceps area of persons aged ≥12 months. Subcutaneous injections may be administered into the upper-outer triceps area of an infant if necessary. A ⅝-inch, 23- to 25-gauge needle should be inserted into the subcutaneous tissue (Figures 4 and 5) (4).

**Oral Route**

Rotavirus, adenovirus, cholera vaccine, and oral typhoid vaccines are the only vaccines administered orally in the United States. Oral typhoid capsules should be administered as directed by the manufacturer. The capsules should not be opened or mixed with any other substance. Rotavirus vaccines are licensed for infants. There are 2 brands of rotavirus vaccine, and they have different types of applicators. Providers should consult package inserts for details.

**Intranasal Route**

Live attenuated influenza vaccine is approved for healthy nonpregnant persons aged 2-49 years and is the only vaccine administered by the intranasal route. The administration device is a nasal sprayer with a dose-divider clip that allows introduction of one 0.1-mL spray into each naris. The tip should be inserted slightly into the naris before
administration. Even if the person coughs or sneezes immediately after administration or the dose is expelled any other way, the vaccine dose need not be repeated (5).

Severely immunosuppressed persons (i.e., those who require care in a protected environment, e.g., bone marrow transplant recipients, individuals with severe combined immunodeficiency diseases) should not administer LAIV. It would be uncommon for persons with these conditions to be in a role administering vaccines. Other persons at increased risk for influenza complications can administer LAIV. These include persons with underlying medical conditions placing them at higher risk or who are likely to be at risk, including pregnant women, persons with asthma, and persons aged ≥50 years (2).

**Multiple Injections**

If multiple vaccines are administered at a single visit, administer each preparation at a different anatomic site (28). The location of all injection sites with the corresponding vaccine injected should be documented in each patient’s medical record. Health-care practices should consider using a vaccination site map so that all persons administering vaccines routinely use a particular anatomic site for each particular vaccine.

For infants and younger children, if more than 2 vaccines are injected in a single limb, the thigh is the preferred site because of the greater muscle mass; the injections should be sufficiently separated (separate anatomic sites [i.e. ≥1 inch] if possible) so that any local reactions can be differentiated (13,29). For older children and adults, the deltoid muscle can be used for more than one intramuscular injection.

If a vaccine and an immune globulin preparation are administered simultaneously (e.g., Td/Tdap and tetanus immune globulin [TIG], hepatitis B and hepatitis B immunoglobulin [HBIG]), separate limbs should be used for each injection (29-30).

**Jet Injections**

Jet injectors are needle-free devices that pressurize liquid medication, forcing it through a nozzle orifice into a narrow stream capable of penetrating skin to deliver a drug or vaccine into intradermal, subcutaneous, or intramuscular tissues (32-33). Immune responses generated by jet injectors against both attenuated and inactivated viral and bacterial antigens are usually equivalent to, and occasionally greater than, immune responses induced by needle injection.
However, local reactions or injuries (e.g., skin laceration, transient neuropathy, hematoma) are sometimes more frequent on delivery of vaccine by jet injectors compared with needle injection, depending on the inherent irritability of the vaccine and operator technique (33).

Multiple use jet injectors using the same nozzle for consecutive injections without intervening sterilization were used in mass vaccination campaigns from the 1950s through the 1990s (33); however, these were found to be unsafe because of the possibility of bloodborne pathogen transmission (34-37) and should not be used. A new generation of jet injectors with disposable cartridges and syringes has been developed since the 1990s. With a new, sterile dose chamber and nozzle for each patient and correct use, these devices do not have the same safety concerns as multiple-use nozzle jet injectors. Several of the newer devices have been approved by FDA for use with specific vaccines (33). Jet injectors prevent needlestick injuries to health-care providers (2) and can overcome improper, unsterile reuse and other drawbacks of needles and syringes in developing countries (9, 38-39).

**Methods for Alleviating Discomfort and Pain Associated with Vaccination**

Comfort measures, such as distraction (e.g., playing music or pretending to blow away the pain), cooling of the injection site(s), topical analgesia, ingestion of sweet liquids, breastfeeding, swaddling, and slow, lateral swaying can help infants or children cope with the discomfort associated with vaccination (40-42). Pretreatment (30-60 minutes before injection) with a 5% topical lidocaine-prilocaine emulsion might decrease the pain of vaccination by causing superficial anesthesia (43-44). Evidence indicates that this cream does not interfere with the immune response to MMR (45). There is no evidence the cream interferes with other vaccines (46-49). Topical lidocaine-prilocaine emulsion should not be used on infants aged <12 months who are receiving treatment with methemoglobin-inducing agents (e.g., acetaminophen, amyl nitrate, nitroprusside, dapsone) because of the possible development of methemoglobinemia (50). Use of a topical refrigerant (vapocoolant) spray immediately before vaccination can reduce the short-term pain associated with injections and can be as effective as lidocaine-prilocaine cream (51). Evidence does not support use of antipyretics before or at the time of vaccination; however, they can be used for the treatment of fever and local discomfort that might occur.
following vaccination. Studies of children with previous febrile seizures have not demonstrated antipyretics to be effective in the prevention of febrile seizures (48).

**Clinical Implications of Nonstandard Vaccination Practices**

Best practice guidance for route, site, and dosage of immunobiologics is derived from data from clinical trials, practical experience, normal intervals of health care visits, and theoretical considerations. ACIP discourages variations from the recommended route, site, volume, or number of doses of any vaccine.

Variation from the recommended route and site can result in inadequate protection. In adults (but not in infants) (52), the immunogenicity of hepatitis B is substantially lower when the gluteal rather than the deltoid site is used for administration (8). Hepatitis B administered intradermally might result in a lower seroconversion rate and final titer of hepatitis B surface antibody than when administered by the deltoid intramuscular route (53-54). Hepatitis B administered by any route other than intramuscular, or in adults at any site other than the deltoid or anterolateral thigh, should not be counted as valid and should be repeated (9). Similarly, doses of rabies vaccine administered in the gluteal site should not be counted as valid doses and should be repeated (54). Hepatitis A vaccine and meningococcal conjugate vaccine do not need to be repeated if administered by the subcutaneous route (55-56). However, for DTaP, Hib, and PCV13, there is no evidence related to immunogenicity of these 3 vaccines given subcutaneously. Providers should address circumstances in which dose(s) of these vaccines have been administered subcutaneously on a case-by-case basis. Inactivated influenza vaccine is immunogenic when administered in a lower-than-standard dose by the intradermal route to healthy adult volunteers. Intradermal injection produced antibody responses similar to intramuscular injection in vaccinees aged 18-60 years (57). However, the immunogenicity for persons aged ≥65 years is inadequate, and varying the recommended route and dose either with the intradermal product licensed through 64 years of age or with other influenza vaccines is not recommended (24).

Live, attenuated injectable vaccines (e.g., MMR, varicella, yellow fever) and certain inactivated vaccines (e.g., meningococcal polysaccharide) are recommended by the manufacturers to be administered by subcutaneous injection. PPSV23 and IPV are
recommended by the manufacturer to be administered by the subcutaneous or intramuscular route. Response to vaccines recommended by the subcutaneous route is unlikely to be affected if the vaccines are administered by the intramuscular rather than subcutaneous route. Repeating doses of vaccine administered by the intramuscular route when recommended to be by the subcutaneous route is not necessary (10).

Administering volumes smaller than recommended (e.g., inappropriately divided doses) might result in inadequate protection. Using reduced doses administered at multiple vaccination visits that equal a full dose or using smaller divided doses is not recommended (4). Any vaccination using less than the standard dose should not be counted, and the person should be revaccinated according to age unless serologic testing indicates that an adequate response has developed. However, if 2 half-volume formulations of vaccine have already been administered on the same clinic day to a patient recommended for the full volume formulation, these 2 doses can count as one full dose. If less than a full recommended dose of a vaccine is administered because of syringe, applicator, or needle leakage, the dose should be repeated (5). Using larger-than-recommended dosages can be hazardous because of excessive local or systemic concentrations of antigens or other vaccine constituents.

(a) If the gluteal muscle is chosen, injection should be administered lateral and superior to a line between the posterior superior iliac spine and the greater trochanter or in the ventrogluteal site, the center of a triangle bounded by the anterior superior iliac spine, the tubercle of the iliac crest, and the upper border of the greater trochanter.
<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Dose</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTaP, DT, Td, Tdap</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>DTaP-HepB-IPV</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>DTaP/Hib</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>DTaP-IPV/Hib</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>DTaP-IPV</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>Hib</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>Hib-MenCY</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>HepA</td>
<td>≤18 years: 0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td></td>
<td>≥19 years: 1.0 mL</td>
<td>IM</td>
</tr>
<tr>
<td>HepB</td>
<td>≤19 years: 0.5 mL(a)</td>
<td>IM</td>
</tr>
<tr>
<td></td>
<td>≥20 years: 1.0 mL</td>
<td>IM</td>
</tr>
<tr>
<td>HepA-HepB</td>
<td>≥18 years: 1.0 mL</td>
<td>IM</td>
</tr>
<tr>
<td>LAIV</td>
<td>0.2 mL divided dose between nares</td>
<td>Intranasal spray</td>
</tr>
<tr>
<td>IIV</td>
<td>6-35 months: 0.25 mL or 0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td></td>
<td>≥3 years: 0.5 mL(b)</td>
<td>IM</td>
</tr>
<tr>
<td>MenB</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>MMR</td>
<td>0.5 mL</td>
<td>Subcut</td>
</tr>
<tr>
<td>MMRV</td>
<td>0.5 mL</td>
<td>Subcut</td>
</tr>
<tr>
<td>MenACWY</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>MPSV4</td>
<td>0.5 mL</td>
<td>Subcut</td>
</tr>
<tr>
<td>PCV13</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>PPSV23</td>
<td>0.5 mL</td>
<td>IM or Subcut</td>
</tr>
<tr>
<td>HPV</td>
<td>0.5 mL</td>
<td>IM</td>
</tr>
<tr>
<td>IPV</td>
<td>0.5 mL</td>
<td>IM or Subcut</td>
</tr>
<tr>
<td>Rotavirus (RV1 or RV5)</td>
<td>(1.0 mL or 2.0 mL)</td>
<td>Oral</td>
</tr>
<tr>
<td>Varicella</td>
<td>0.5 mL</td>
<td>Subcut</td>
</tr>
<tr>
<td>RZV</td>
<td>0.5 mL(c)</td>
<td>IM</td>
</tr>
</tbody>
</table>

**Abbreviations:** DT = diphtheria and tetanus toxoids; DTaP = diphtheria and tetanus toxoids and acellular pertussis; HepA = hepatitis A; HepB = hepatitis B; Hib = *Haemophilus influenzae* type b; HPV = human papillomavirus; IIV = inactivated influenza vaccine; IM = intramuscular; IPV = inactivated poliovirus; LAIV = live, attenuated influenza vaccine; MenACWY = quadrivalent meningococcal conjugate vaccine; MenCY = bivalent meningococcal conjugate vaccine component; MMR = measles, mumps, and rubella; MMRV = measles, mumps, rubella, and varicella; MPSV4 = quadrivalent meningococcal polysaccharide vaccine; PCV13 = pneumococcal conjugate vaccine; PPSV23 = pneumococcal polysaccharide vaccine; RV1 = live, attenuated monovalent rotavirus vaccine; RV5 = live, reassortment pentavalent rotavirus vaccine; RZV = recombinant adjuvanted zoster vaccine; Subcut = subcutaneous; Td = tetanus and diphtheria toxoids; Tdap = tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis.
<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Dose</th>
<th>Route</th>
</tr>
</thead>
</table>

**Source:** Adapted from Immunization Action Coalition: [http://www.immunize.org](http://www.immunize.org).

(a) Persons aged 11-15 years may be administered Recombivax HB (Merck), 1.0 mL (adult formulation) on a 2-dose schedule.

(b) Note that prefilled syringes of High-Dose Fluzone have a volume of 0.7 cc and the recommended volume of administration is 0.7 ccs.

Do not withdraw more than 0.5 mL from the reconstituted product, even if some product is left in the vial.
<table>
<thead>
<tr>
<th>Age group</th>
<th>Needle length</th>
<th>Injection site</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children (birth-18 years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neonates(^{(a)})</td>
<td>5/8 inch (16 mm)(^{(b)})</td>
<td>Anterolateral thigh</td>
</tr>
<tr>
<td>Infants, 1-12 months</td>
<td>1 inch (25 mm)</td>
<td>Anterolateral thigh</td>
</tr>
<tr>
<td>Toddlers, 1-2 years</td>
<td>1-1.25 inch (25-32 mm)</td>
<td>Anterolateral thigh(^{(c)})</td>
</tr>
<tr>
<td></td>
<td>5/8(^{(b)})-1 inch (16-25 mm)</td>
<td>Deltoid muscle of arm</td>
</tr>
<tr>
<td>Children, 3-10 years</td>
<td>5/8(^{(b)})-1 inch (16-25 mm)</td>
<td>Deltoid muscle of arm(^{(c)})</td>
</tr>
<tr>
<td></td>
<td>1-1.25 inches (25-32 mm)</td>
<td>Anterolateral thigh</td>
</tr>
<tr>
<td>Children, 11-18 years</td>
<td>5/8(^{(b)})-1 inch (16-25 mm)</td>
<td>Deltoid muscle of arm(^{(c)})</td>
</tr>
<tr>
<td></td>
<td>1-1.5 inches (25-38 mm)</td>
<td>Anterolateral thigh</td>
</tr>
<tr>
<td><strong>Adults (≥19 years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men and women, &lt;60 kg (130 lbs)</td>
<td>1 inch (25 mm) (^{(d)})</td>
<td>Deltoid muscle of arm</td>
</tr>
<tr>
<td>Men and women, 60-70 kg (130-152 lbs)</td>
<td>1 inch (25 mm)</td>
<td></td>
</tr>
<tr>
<td>Men, 70-118 kg (152-260 lbs)</td>
<td>1-1.5 inches (25-38 mm)</td>
<td></td>
</tr>
<tr>
<td>Women, 70-90 kg (152-200 lbs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men, &gt;118 kg (260 lbs)</td>
<td>1.5 inches (38 mm)</td>
<td></td>
</tr>
<tr>
<td>Women, &gt;90 kg (200 lbs)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviation:** IM = intramuscular.

**Source:** (14).
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>First 28 days of life.</td>
</tr>
<tr>
<td>(b)</td>
<td>If skin is stretched tightly and subcutaneous tissues are not bunched.</td>
</tr>
<tr>
<td>(c)</td>
<td>Preferred site.</td>
</tr>
<tr>
<td>(d)</td>
<td>Some experts recommend a 5/8-inch needle for men and women who weigh &lt;60 kg, if used, skin must be stretched tightly (do not bunch subcutaneous tissue)</td>
</tr>
</tbody>
</table>
Figure 1. Intramuscular needle insertion

Source: Adapted from California Immunization Branch.

Alternate Text: This drawing shows intramuscular needle insertion into a cross-section of skin. The needle is inserted at a 90-degree angle and penetrates the dermis, fatty tissue (subcutaneous), and muscle tissue.
Figure 2. Intramuscular/subcutaneous site of administration: anterolateral thigh

Source: Adapted from Minnesota Department of Health.

Alternate Text: This drawing shows a mother holding an infant. The anterolateral aspect of the infant’s thigh is shaded, showing the proper site for intramuscular/subcutaneous vaccine administration.
Figure 3. Intramuscular site of administration: deltoid

Source: Adapted from Minnesota Department of Health.

Alternate Text: This line drawing is a side view of an adult. The deltoid muscle of the arm is shaded, showing the proper site for intramuscular vaccine administration.
Figure 4. Subcutaneous site of administration: triceps

Source: Adapted from the Minnesota Department of Health.

Alternate Text: This line drawing is a rear/dorsal view of an adult. The triceps muscle of the arm is shaded, showing the proper site for subcutaneous vaccine administration.
Figure 5. Subcutaneous needle insertion

Source: Adapted from California Immunization Branch.

Alternate Text: This drawing shows subcutaneous needle insertion into a cross-section of skin. The needle is inserted at a 45-degree angle and penetrates the dermis and fatty tissue (subcutaneous) but not the muscle tissue.
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