

Tetanus is an acute, often fatal, disease caused by an exotoxin produced by the bacterium *Clostridium tetani*. It is characterized by generalized rigidity and convulsive spasms of skeletal muscles. The muscle stiffness usually begins in the jaw (lockjaw) and neck and then becomes generalized.

Although records from antiquity (5th century BCE) contain clinical descriptions of tetanus, it was in 1884 when tetanus was first produced in animals by injecting them with pus from a fatal human tetanus case. During the same year, tetanus was produced in animals by injecting them with samples of soil. In 1889, Kitasato Shibasaburo isolated the organism from a human, showed that it produced disease when injected into animals, and reported that the toxin could be neutralized by specific antibodies. In 1897, Edmond Nocard demonstrated the protective effect of passively transferred antitoxin, and passive immunization in humans was used for treatment and prophylaxis during World War I. A method for inactivating tetanus toxin with formaldehyde was developed in the early 1920s. This led to the development of tetanus toxoid in 1924. It was first widely used during World War II.

### ***Clostridium tetani***

The *C. tetani* bacterium is a spore-forming, gram-positive, slender, anaerobic rod. The organism is sensitive to heat and cannot survive in the presence of oxygen. The spores, in contrast, are extremely resistant to heat and the usual antiseptics. They can survive autoclaving at 249.8°F (121°C) for 10 to 15 minutes. The spores are also relatively resistant to phenol and other chemical agents.

The spores are widely distributed in soil and in the intestines and feces of horses, sheep, cattle, dogs, cats, rats, guinea pigs, and chickens. Manure-treated soil may contain large numbers of spores. In agricultural areas, a significant number of human adults may harbor the organism. The spores can also be found on skin surfaces and in contaminated heroin.

*C. tetani* produces two exotoxins, tetanolysin and tetanospasmin. Tetanospasmin is a neurotoxin and causes the clinical manifestations of tetanus. On the basis of weight, tetanospasmin is one of the most potent toxins known: the estimated minimum human lethal dose is 2.5 nanograms per kilogram of body weight (a nanogram is one billionth of a gram) or 175 nanograms for a 70-kg (154-lb) human.

#### **Tetanus**

- Caused by exotoxin produced by bacterium *Clostridium tetani*
- Characterized by generalized rigidity and convulsive spasms
- First produced in animals in 1884
- Organism isolated in 1889
- Tetanus toxoid developed in 1924 and widely used during World War II

#### ***Clostridium tetani***

- Anaerobic gram-positive, spore-forming bacteria
- Spores found in soil and intestines and feces of some animals
- Spores resistant to heat and antiseptics
- Two exotoxins produced with growth of bacteria

# Tetanus

## Tetanus Pathogenesis

- Enters body through wound
- Spores germinate in anaerobic conditions
- Toxin binds in central nervous system
- Interferes with neurotransmitter release to block inhibitor impulses
- Leads to unopposed muscle contraction and spasm

## Tetanus Clinical Features

- Incubation period 8 days (range, 1 to 21 days)
- Three forms: Generalized (most common), local (uncommon), cephalic (rare)
- Generalized tetanus: Trismus (lockjaw), stiffness of the neck, difficulty swallowing, rigidity of abdominal muscles
  - Spasms continue for 3 to 4 weeks
  - Complete recovery may take months

## Pathogenesis

*C. tetani* usually enters the body through a wound. In the presence of anaerobic conditions, the spores germinate. Toxins are produced and disseminated via blood and lymphatics. Tetanospasmin, also referred to as tetanus toxin, acts at several sites within the central nervous system, including peripheral motor end plates, the spinal cord, and the brain, and in the sympathetic nervous system. The typical clinical manifestations of tetanus are caused when tetanus toxin interferes with the release of neurotransmitters, blocking inhibitor impulses. This leads to unopposed muscle contraction and spasm. Seizures may occur, and the autonomic nervous system may also be affected.

## Clinical Features

The incubation period is usually about 8 days, with a usual range of 1 to 21 days. In general, the incubation period is longer the further the injury site is from the central nervous system. Shorter incubation periods are also associated with severe disease and a higher chance of death.

On the basis of clinical findings, three different forms of tetanus have been described. The most common type (more than 80% of reported cases) is generalized tetanus. The disease usually presents with a descending pattern. The first sign is trismus, or lockjaw, followed by stiffness of the neck, difficulty in swallowing, and rigidity of abdominal muscles. Other symptoms include elevated temperature, sweating, elevated blood pressure, and episodic rapid heart rate. Spasms may occur frequently and last for several minutes. Spasms continue for 3 to 4 weeks. Complete recovery may take months.

Localized tetanus is an uncommon form of the disease in which patients have persistent contraction of muscles in the same anatomic area as the injury. These contractions may persist for many weeks before gradually subsiding. Localized tetanus may precede the onset of generalized tetanus but is generally milder.

Cephalic tetanus is a rare form of the disease, occasionally occurring with otitis media in which *C. tetani* is present in the flora of the middle ear or following injuries to the head. There is involvement of the cranial nerves, especially in the facial area.

Neonatal tetanus is a form of generalized tetanus that occurs in newborn infants. Neonatal tetanus occurs in infants born without protective passive immunity because the mother is not immune. It usually occurs through infection of the unhealed umbilical stump, particularly when the stump is cut with an unsterile instrument. In neonatal tetanus, symptoms usually appear from 4 to 14 days after birth, averaging about 7 days.

## Complications

Laryngospasm or spasm of the muscles of respiration leads to interference with breathing. Fractures of the spine or long bones may result from sustained contractions and convulsions. Hyperactivity of the autonomic nervous system may lead to hypertension or an abnormal heart rhythm.

Nosocomial infections are common because of prolonged hospitalization. Secondary infections may include sepsis from indwelling catheters, hospital-acquired pneumonias, and decubitus ulcers. Pulmonary embolism is particularly a problem in persons who use drugs and elderly patients. Aspiration pneumonia is a common late complication of tetanus, found in 50% to 70% of autopsied cases. In recent years, tetanus has been fatal in approximately 11% of reported cases. Cases most likely to be fatal are those occurring in persons age 60 years or older and unvaccinated persons. In about 20% of tetanus deaths, no obvious pathology is identified and death is attributed to the direct effects of tetanus toxin.

### Tetanus Complications

- Laryngospasm
- Fractures
- Hypertension and/or abnormal heart rhythm
- Nosocomial infections
- Pulmonary embolism
- Aspiration pneumonia
- Death

## Laboratory Testing

The diagnosis of tetanus is entirely clinical and does not depend upon bacteriologic confirmation. *C. tetani* is recovered from the wound in only 30% of cases and can be isolated from patients who do not have tetanus. Laboratory identification of the organism depends most importantly on the demonstration of toxin production in mice.

## Medical Management

All wounds should be cleaned. Necrotic tissue and foreign material should be removed. If tetanic spasms are occurring, supportive therapy and maintenance of an adequate airway are critical.

Tetanus immune globulin (TIG) is recommended for persons with tetanus. TIG can only help remove unbound tetanus toxin. It cannot affect toxin bound to nerve endings. A single intramuscular dose of 500 units is generally recommended for children and adults, with part of the dose infiltrated around the wound if it can be identified. Intravenous immune globulin (IVIG) contains tetanus antitoxin and may be used if TIG is not available.

Because of the extreme potency of the toxin, tetanus disease does not result in tetanus immunity. Active immunization with tetanus toxoid should begin or continue as soon as the person's condition has stabilized.

Antibiotic prophylaxis against tetanus is neither practical nor useful in managing wounds; immunization plays the more important role. The need for active immunization, with or without passive immunization, depends on the condition of

the wound and the patient's immunization history. Rarely have cases of tetanus occurred in persons with a documented primary series of tetanus toxoid.

Persons with wounds that are neither clean nor minor, and who have had fewer than 3 prior doses of tetanus toxoid or have an unknown history of prior doses, should receive TIG as well as tetanus toxoid vaccine. This is because early doses of toxoid may prime the immune system but not induce immunity. TIG provides temporary immunity by directly providing antitoxin. This ensures that protective levels of antitoxin are achieved even if an immune response has not yet occurred.

## Guide to Tetanus Prophylaxis with TIG in Routine Wound Management

History of adsorbed tetanus toxoid-containing vaccines (doses)	Clean, minor wounds DTaP, Tdap or Td <sup>†</sup>	Clean, minor wounds TIG <sup>‡</sup>	All other wounds* DTaP, Tdap or Td <sup>†</sup>	All other wounds* TIG <sup>§</sup>
Unknown or < 3 doses	Yes	No	Yes	Yes
≥3	No <sup>¶</sup>	No	No <sup>**</sup>	No

\*Such as, but not limited to, wounds contaminated with dirt, feces, soil, or saliva; puncture wounds; avulsions; and wounds resulting from missiles, crushing, burns, and frostbite.

<sup>†</sup>DTaP is recommended for children younger than age 7 years. Tdap is preferred to Td for persons age 11 years or older who have not previously received Tdap. Persons age 7 years or older who are not fully immunized against pertussis, tetanus, or diphtheria should receive one dose of Tdap (preferably the first) for wound management and as part of the catch-up series; if additional tetanus toxoid-containing doses are required, either Td or Tdap vaccine can be used.

<sup>§</sup>People with HIV infection or severe immunodeficiency who have contaminated wounds (including minor wounds) should also receive TIG, regardless of their history of tetanus immunizations.

<sup>¶</sup>Yes, if ≥10 years since the last tetanus toxoid-containing vaccine dose.

<sup>\*\*</sup>Yes, if ≥5 years since the last tetanus toxoid-containing vaccine dose.

### Tetanus Epidemiology

- Reservoir
  - Soil and intestine of animals and humans
- Transmission
  - Contaminated wounds
- Temporal pattern
  - Temperate climate: Peaks in summer
  - Tropical climate: Year-round, but may rise during wet seasons
- Communicability
  - Not contagious

## Epidemiology

### Occurrence

Tetanus occurs worldwide but is most frequently encountered in densely populated regions in hot, damp climates with soil rich in organic matter.

### Reservoir

Organisms are found primarily in the soil and intestinal tracts of animals and humans.

### Transmission

Transmission is primarily by contaminated wounds (apparent and inapparent). The wound may be major or minor. In recent years, a higher proportion of tetanus cases had minor wounds, probably because severe wounds are more likely to be appropriately managed. Tetanus may follow elective surgery, burns, deep puncture wounds, crush wounds, otitis media, dental infection, and animal bites.

## Temporal Pattern

In temperate climates, tetanus peaks in the summer. In tropical climates, tetanus generally occurs year round, but may rise during the wet season in some areas.

## Communicability

Tetanus is not contagious from person-to-person. It is the only vaccine-preventable disease that is infectious but not contagious.

## Secular Trends in the United States

A marked decrease in mortality from tetanus occurred from the early 1900s to the late 1940s. In the late 1940s, tetanus toxoid-containing vaccines were introduced into routine childhood vaccination and tetanus became a nationally notifiable disease. At that time, between 500–600 cases (approximately 0.4 cases per 100,000 population) were reported per year.

After the 1940s, reported tetanus incidence rates declined steadily. Since the mid-1970s, about 50 to 100 cases (approximately 0.05 cases per 100,000) have been reported annually in the United States. More recently, from 2009–2018, an average of 29 (range 18–37) cases were reported per year. Of the 297 cases reported during this 10-year timeframe, there were 19 deaths, all in adults age 55 years or older. In 2018, 23 tetanus cases were reported, with no deaths.

Among children born during 2016–2017, 93.3% had received at least 3 doses of DTaP vaccine by age 24 months, and 80.6% had received at least 4 doses of DTaP vaccine by age 24 months. Tdap coverage among adolescents age 13 through 17 years reached 90.2% in 2019. Coverage with tetanus toxoid vaccines among adults is lower; the estimates for any dose of a tetanus toxoid-containing vaccine (Td or Tdap) among adults was 63.4% in 2017.

## Tetanus Toxoid-containing Vaccines

Tetanus toxoid is combined with diphtheria toxoid as diphtheria and tetanus toxoid (DT) vaccine or tetanus and diphtheria toxoid (Td [Tenvirac and Tdvax]) vaccine. Tetanus toxoid is also combined with both diphtheria toxoid and acellular pertussis vaccine as DTaP (Infanrix and Daptacel) or Tdap (Boostrix and Adacel) vaccines. Td contains reduced amounts of diphtheria toxoid compared with DT. DTaP and Tdap contain the same pertussis components, but Tdap contains a reduced quantity of some pertussis antigens and diphtheria toxoid. Boostrix contains a reduced quantity of tetanus toxoid compared to Infanrix.

### Tetanus Secular Trends in the United States

- 500-600 cases annually before vaccine
- Since the mid-1970s, ~50-100 cases annually
- In 2018, 23 cases were reported with no deaths

### Tetanus Toxoid-containing Vaccines

- DT
- DTaP (Daptacel and Infanrix)
- Td (Tdvax and Tenvirac)
- Tdap (Adacel and Boostrix)
- DTaP-HepB-IPV (Pediarix)
- DTaP-IPV/Hib (Pentacel)
- DTaP-IPV (Kinrix and Quadracel)
- DTaP-IPV-Hib-HepB (Vaxelis)

Children younger than age 7 years should receive DTaP vaccine or DT vaccine (in instances where the pertussis vaccine component is contraindicated or where the physician decides that pertussis vaccine is not to be administered). Persons age 7 years or older should receive Td vaccine or Tdap vaccine, even if they have not completed a series of DTaP or DT (Tdap would be off-label for children age 7 through 9 years, but is still recommended by ACIP). Tdap (Boostrix) is approved for persons age 10 years or older; Tdap (Adacel) is approved for persons age 10 through 64 years. DTP vaccines are combined diphtheria and tetanus toxoids and whole cell pertussis vaccine, but none are currently licensed in the United States.

There are five combination vaccines that contain DTaP vaccine. DTaP-HepB-IPV (Pediarix) is licensed for the first 3 doses of the DTaP series among children age 6 weeks through 6 years. DTaP-IPV/Hib (Pentacel) is licensed for the first 4 doses of the component vaccines among children age 6 weeks through 4 years. DTaP-IPV (Kinrix) is licensed only for the fifth dose of DTaP and fourth dose of IPV among children age 4 through 6 years. DTaP-IPV (Quadacel) is licensed only for the fourth dose of DTaP and fourth or fifth dose of IPV among children age 4 through 6 years. DTaP-IPV-Hib-HepB (Vaxelis) is licensed for use in children age 6 weeks through 4 years.

### Tetanus Toxoid-containing Vaccine Characteristics

- Administered by intramuscular injection
- Contains aluminum as an adjuvant

### Tetanus Toxoid-containing Vaccination Schedule

- DTaP
  - 3-dose primary series at age 2, 4, and 6 months
  - Primary series interval of 4- to 8-weeks and minimum interval 4 weeks
  - Boosters at age 15 through 18 months and age 4 through 6 years
  - Minimum interval for dose 4 is 6 months from dose 3 and minimum age is 12 months
  - If dose 4 is given on or after 4th birthday, the 5th dose is optional
  - DT is used in place of DTaP if child has a valid contraindication to pertussis vaccine

## Characteristics

Tetanus toxoid-containing vaccines are administered by intramuscular injection. Each dose of tetanus toxoid-containing vaccines contains aluminum as an adjuvant but no preservative. DTaP-HepB-IPV (Pediarix), DTaP-IPV/Hib (Pentacel), DTaP-IPV-Hib-HepB (Vaxelis), DTaP-IPV (Kinrix), and DTaP-IPV (Quadacel) contain neomycin and polymyxin B as antibiotics. DTaP-IPV-Hib-HepB (Vaxelis) contains streptomycin as an antibiotic. DTaP-HepB-IPV (Pediarix) and DTaP-IPV-Hib-HepB (Vaxelis) vaccines contain yeast protein. Presentations of some tetanus toxoid-containing vaccines contain latex rubber.

## Vaccination Schedule and Use

### DTaP (Infanrix and Daptacel)

DTaP (diphtheria, tetanus toxoids, and acellular pertussis vaccine) is recommended for children age 6 weeks through 6 years. The routine schedule is a primary series of 3 doses at age 2, 4, and 6 months, a booster dose between age 15 through 18 months, and another booster dose between age 4 through 6 years (total of 5 doses). The first 3 doses should be given at 4- to 8-week intervals (minimum of 4 weeks). Dose 4 should follow dose 3 by no less than 6 months and should not be administered before age 12 months.

Dose 4 of both brands of DTaP is recommended to be administered at age 15 through 18 months (15 through 20 months for Daptacel). Dose 4 may be given as early as age 12 months if at least 6 months have elapsed since dose 3 and, in the opinion of the vaccine provider, the child is unlikely to return for an additional visit between age 15 through 18 months.

Children who received 4 doses before their fourth birthday should receive a fifth dose of DTaP before entering school. The fifth dose is not necessary (but may be given) if dose 4 in the series was given on or after the fourth birthday. Administering the fifth dose increases antibody levels and may decrease the risk of school-age children transmitting the disease to younger siblings who are not fully vaccinated.

If a child has a valid contraindication to pertussis vaccine, DT should be used to complete the vaccination series. If the child was younger than age 12 months when the first dose of DT was administered (as DTP, DTaP, or DT), the child should receive a total of 4 DT doses. If the child was age 12 months or older at the time the first dose of DT was administered, 3 doses (with dose 3 administered 6 through 12 months after dose 2) will complete the primary DT series. If dose 4 of DTP, DTaP, or DT is administered before the fourth birthday, a fifth dose is recommended at age 4 through 6 years.

### **DTaP-HepB-IPV (Pediarix)**

DTaP-HepB-IPV vaccine is approved for use as a 3-dose series for children age 6 weeks through 6 years. It is administered to infants at age 2, 4, and 6 months. The minimum intervals for DTaP-HepB-IPV vaccine are determined by the DTaP component. The 3 doses must be separated by at least 4 weeks between doses. Because the minimum age for the first dose of DTaP-HepB-IPV vaccine is 6 weeks, this vaccine cannot be used for the birth dose of hepatitis B (HepB) vaccine. The final dose of DTaP-HepB-IPV vaccine should be administered at age 24 weeks or older, the minimum age for completion of the hepatitis B vaccine series. When DTaP-HepB-IPV vaccine is used to provide 3 doses at age 2, 4, and 6 months (based on the DTaP and IPV schedules), this will result in a 4-dose HepB vaccine series, which is acceptable.

### **DTaP-IPV/Hib (Pentacel)**

DTaP-IPV/Hib vaccine is approved for use as a 4-dose series for children age 6 weeks through 4 years. It is administered to infants at age 2, 4, 6, and 15 through 18 months. The minimum intervals for DTaP-IPV/Hib vaccine are determined by the DTaP component. The first 3 doses must be separated by at least 4 weeks between doses. Dose 4 must be separated from dose 3 by at least 6 months, and should not be administered before age 12 months. When DTaP-IPV/Hib vaccine is used

to provide 4 doses at age 2, 4, 6, and between 15 through 18 months (based on the DTaP and Hib schedules), an additional booster dose with IPV-stand alone or DTaP-IPV vaccine should be administered at age 4 through 6 years. This will result in a 5-dose IPV vaccine series, which is acceptable.

### **DTaP-IPV-Hib-HepB (Vaxelis)**

DTaP-IPV-Hib-HepB is approved for use as a 3-dose series for children age 6 weeks through 4 years. It is administered to infants at age 2, 4, and 6 months. The minimum intervals for DTaP-IPV-Hib-HepB vaccine are determined by the DTaP component. The 3 doses must be separated by at least 4 weeks between doses. Because the minimum age for the first dose of DTaP-IPV-Hib-HepB vaccine is 6 weeks, this vaccine cannot be used for the birth dose of hepatitis B (HepB) vaccine. The final dose of DTaP-IPV-Hib-HepB vaccine should be administered at age 24 weeks or older, the minimum age for completion of the hepatitis B vaccine series. When DTaP-IPV-Hib-HepB vaccine is used to provide 3 doses at age 2, 4, and 6 months (based on the DTaP and IPV schedules), this will result in a 4-dose HepB vaccine series, which is acceptable.

### **DTaP-IPV (Kinrix)**

DTaP-IPV (Kinrix) vaccine is approved only for dose 5 of DTaP vaccine and dose 4 of IPV vaccine in children age 4 through 6 years whose previous DTaP vaccine doses have been with Infanrix and/or Pediarix for dose 1, 2, and 3 and Infanrix for dose 4. However, if DTaP-IPV (Kinrix) vaccine is administered to children who received another brand of DTaP vaccine for prior DTaP vaccine doses, or if administered as dose 1, 2, 3, or 4 of the DTaP vaccine series or dose 1, 2, or 3 of the IPV vaccine series, the dose of DTaP-IPV (Kinrix) does not need to be repeated.

### **DTaP-IPV (Quadracel)**

DTaP-IPV (Quadracel) vaccine is approved only for dose 5 of DTaP vaccine and dose 4 or 5 of IPV vaccine in children age 4 through 6 years who have received 4 doses of Pentacel and/or Daptacel vaccine. However, if DTaP-IPV (Quadracel) vaccine is administered to children who received another brand of DTaP vaccine for prior DTaP vaccines doses, or if administered as dose 1, 2, 3, or 4 of the DTaP vaccine series or dose 1, 2, or 3 of the IPV series, the dose of DTaP-IPV (Quadracel) does not need to be repeated.

### **Tdap (Boostrix and Adacel) and Td (Tenivac and Tdavax)**

Both Tdap vaccines are approved by the FDA for a booster dose for persons who have completed the recommended childhood DTP/DTaP vaccination series. Boostrix is approved for persons age 10 years or older. Adacel is approved for a single dose in persons age 10 through 64 years. A second dose of Adacel is also licensed for administration 8 or more years

#### **Tetanus Toxoid-containing Vaccination Schedule**

- Tdap
  - 1 dose at age 11 through 18 for adolescents who have completed DTaP series
  - Booster dose of Td or Tdap every 10 years for all persons



after the first Tdap dose and for use for tetanus prophylaxis when indicated for wound management if at least 5 years have elapsed since the previous receipt of any tetanus toxoid-containing vaccine. Both Td vaccines are approved for use in persons age 7 years or older.

A single Tdap dose is recommended for adolescents age 11 through 18 years who have completed the recommended childhood DTP/DTaP vaccination series, preferably at age 11 through 12 years. Adults age 19 years or older who have not previously received Tdap should receive a single dose of Tdap. To reduce the burden of pertussis in infants, a dose of Tdap has been recommended during each pregnancy since 2012, although this practice is an off-label use.

All adolescents and adults should have received a primary series of at least 3 documented doses of tetanus and diphtheria toxoids-containing vaccine (i.e., DTaP, DTP, DT, or Td) during their lifetime. A person without such documentation should receive a series of 3 doses of tetanus- and diphtheria-containing vaccine. One of these doses, preferably the first, should be Tdap. The remaining 2 doses should be either Td or Tdap.

For persons age 7 to 9 years who receive a dose of Tdap as part of the catch-up series, an adolescent Tdap dose should be administered at age 11 through 12 years. If a Tdap dose is administered at age 10 years or older, the Tdap dose may count as the adolescent Tdap dose. Either brand of Tdap may be used.

Adults age 19 years or older who previously have not received Tdap should receive a single dose of Tdap to protect against pertussis and reduce the likelihood of transmission. For adults age 19 through 64 years, either brand of Tdap may be used. Adults age 65 years or older should be vaccinated with Boostrix, if feasible. However, either vaccine administered to a person age 65 years or older is immunogenic and would provide protection. A dose of either vaccine would be considered valid.

Adolescents and adults who have not previously received Tdap, and have or anticipate having close contact with an infant younger than age 12 months (e.g., parents, siblings, grandparents, child care providers, and health care personnel) should receive a single dose of Tdap to protect against pertussis. Ideally, these persons should receive Tdap at least 2 weeks before beginning close contact with the infant.

Health care personnel should receive a single dose of Tdap as soon as feasible if they have not previously received Tdap, regardless of the time since their most recent Td vaccination.

When Tdap is indicated (e.g., routine vaccination, catch-up vaccination, or pregnancy), it can be administered regardless of the interval since the last tetanus- or diphtheria-toxoid-

### Use of Tdap

- 1 dose Tdap during each pregnancy (off-label use)
- 1 dose Tdap for the following with no previous documentation of Tdap: adults, adolescents and adults who have or anticipate having close contact with an infant younger than age 12 months, and health care personnel
- 3 doses of tetanus- and diphtheria-containing vaccine (1 dose should be Tdap) for adolescents and adults without documentation of a primary series

containing vaccine. After receipt of Tdap, persons should continue to receive a dose of Td or Tdap for routine booster immunization against tetanus and diphtheria every 10 years unless needed sooner for tetanus prophylaxis as part of wound management.

## Vaccination during Pregnancy

Pregnant women who have completed the childhood immunization schedule and were last vaccinated greater than 10 years previously should receive a booster dose of tetanus toxoid-containing vaccine to prevent neonatal tetanus. The risk for neonatal tetanus is minimal if a previously unvaccinated woman has received at least 2 properly spaced doses of a tetanus toxoid-containing vaccine during pregnancy; at least 1 of the doses administered during pregnancy should be Tdap, administered according to published guidance. If more than 1 dose is needed, either Td or Tdap may be used. The 3-dose primary series should be completed at the recommended intervals.

### Tetanus Toxoid-containing Vaccine Efficacy

- After valid 3-dose primary series and booster (children) or 3 valid doses (adults), essentially all recipients achieve antitoxin levels great than protective level
- Antitoxin levels decrease with time so boosters are recommended every 10 years
- Small percentage of individuals are unprotected before 10 years, so booster for wound needed if more than 5 years have elapsed since last dose

## Immunogenicity and Vaccine Efficacy

After a primary series of 3 properly spaced doses of tetanus toxoid-containing vaccines in infants and a booster at 15 through 18 months of age or 3 properly spaced doses in adults, essentially all recipients achieve antitoxin levels considerably greater than the protective level of 0.1 IU/mL.

Efficacy of the tetanus toxoid has never been studied in a vaccine trial. It can be inferred from protective antitoxin levels that a complete tetanus toxoid series has an efficacy of almost 100%. In the series of 233 cases from 2001–2008, only 7 cases (3%) had received a complete tetanus toxoid series with the last dose within the last 10 years.

Antitoxin levels decrease with time. By 10 years after the last dose, most persons have antitoxin levels that only approach the minimal protective level. As a result, routine boosters are recommended every 10 years.

In a small percentage of individuals, antitoxin levels fall below the minimal protective level before 10 years have elapsed. To ensure adequate protective antitoxin levels, persons who sustain a wound that is other than clean and minor should receive a tetanus booster if more than 5 years have elapsed since their last dose.

## Contraindications and Precautions to Vaccination

As with other vaccines, a history of a severe allergic reaction (anaphylaxis) to a vaccine component or following a prior dose is a contraindication to further doses. Moderate or severe

acute illness (with or without fever) in a patient is considered a precaution to vaccination, although persons with minor illness may be vaccinated. If moderate to severe acute illness accompanies a wound that is neither clean nor minor, the risk of withholding tetanus-toxoid vaccine outweighs the risk of administering tetanus-toxoid vaccine, so the vaccine should be given as part of wound management.

Contraindications to combination vaccines that contain DTaP include the contraindications to the individual component vaccines (e.g., IPV, hepatitis B, Hib), but specific ingredients might differ. DTaP-HepB-IPV (Pediarix) and DTaP-IPV-Hib-HepB (Vaxelis) vaccines contain yeast. Presentations of some tetanus toxoid-containing vaccines contain latex rubber. DTaP-HepB-IPV (Pediarix), DTaP-IPV/Hib (Pentacel), DTaP-IPV-Hib-HepB (Vaxelis), DTaP-IPV (Kinrix), and DTaP-IPV (Quadracel) contain neomycin and polymyxin B. DTaP-IPV-Hib-HepB (Vaxelis) contains streptomycin.

Encephalopathy not attributable to another identifiable cause occurring within 7 days after vaccination with DTaP, DTP, or Tdap is a contraindication for DTaP and Tdap vaccination.

A progressive or unstable neurological disorder, uncontrolled seizures, or progressive encephalopathy is a precaution for DTaP and Tdap vaccination. For persons with a known or suspected neurologic condition, vaccination with DTaP or Tdap should be delayed until the condition has been evaluated, treatment initiated, and the condition stabilized. These conditions include the presence of an evolving neurologic disorder (e.g., uncontrolled epilepsy, infantile spasms, and progressive encephalopathy); a history of seizures that has not been evaluated; or a neurologic event that occurs between doses of vaccine. A family history of seizures or other neurologic diseases, or stable or resolved neurologic conditions (e.g., controlled idiopathic epilepsy, cerebral palsy, developmental delay), are neither contraindications nor precautions to DTaP or Tdap vaccination.

Guillain-Barré syndrome within 6 weeks after a previous dose of tetanus toxoid-containing vaccine is a precaution for DTaP, Tdap, DT, and Td vaccination.

A history of Arthus-type hypersensitivity reactions after a previous dose of diphtheria toxoid-containing or tetanus toxoid-containing vaccine is a precaution for DTaP, Tdap, DT, and Td vaccination; vaccination should be deferred until at least 10 years have elapsed since the last tetanus toxoid-containing vaccine.

### Diphtheria and Tetanus Toxoids-containing Vaccine Contraindications and Precautions

- Contraindication
  - Severe allergic reaction to vaccine component or following a prior dose
  - Encephalopathy not attributable to another identifiable cause within 7 days after vaccination\*
- Precaution
  - Moderate or severe acute illness
  - Progressive or unstable neurological disorder\*
  - Uncontrolled seizures\*
  - Progressive encephalopathy\*
  - Guillain-Barré syndrome 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- or tetanus toxoid-containing vaccine\*\*

\*DTaP and Tdap

\*\*DTaP, DT, Tdap, Td

## Tetanus Toxoid-containing Vaccine Safety

### DTaP

- Pain, redness, or swelling
  - 20%-40%
  - More frequent after dose 4 or 5
- Temperature of 101°F
  - 3%-5%
- Moderate or severe systemic reactions
  - Fewer than 1 in 10,000 doses
- Arthus-type reactions are rare

### Tdap, Td

- Pain, redness, or swelling
  - 21%-75%
- Temperature of 100.4°F or higher
  - 1.1%-5%

## Vaccine Safety

DTaP vaccine may cause local reactions, such as pain, redness, or swelling. Local reactions have been reported in 20% to 40% of children after each of the first 3 doses. Local reactions appear to be more frequent after the fourth and/or fifth doses. Mild systemic reactions such as drowsiness, fretfulness, and low-grade fever may also occur. Temperature of 101°F or higher is reported in 3% to 5% of DTaP recipients. These reactions are self-limited and can be managed with symptomatic treatment with acetaminophen or ibuprofen.

Moderate or severe systemic reactions (such as fever of 105°F or higher, febrile seizures, persistent crying lasting 3 hours or longer, and hypotonic-hyporesponsive episodes) have been reported after administration of DTaP, but occur less frequently than among children who received whole-cell DTP. Rates of moderate or severe systemic reactions vary by symptom and vaccine but generally occur in fewer than 1 in 10,000 doses.

Exaggerated local (Arthus-type) reactions are rarely reported but may occur following receipt of a vaccine containing diphtheria or tetanus toxoids.

The most common adverse reaction following vaccination with both brands of Tdap is a local reaction, such as pain (66% to 75%), redness (25%), or swelling (21%) at the site of injection. Temperature of 100.4°F or higher was reported by 1.4% to 5% of Tdap recipients and 1.1% to 5% of Td recipients. Tdap recipients also reported a variety of nonspecific systemic events, such as headache, fatigue and gastrointestinal symptoms.

The Institute of Medicine reported in 2011 that the evidence was inadequate to accept or reject a causal relation between receipt of diphtheria toxoid and tetanus toxoid-containing vaccine and encephalitis, encephalopathy, infantile spasms, seizures, ataxia, autism, acute disseminated encephalomyelitis, transverse myelitis, optic neuritis, onset of multiple sclerosis in adults, relapse of multiple sclerosis in adults, relapse of multiple sclerosis in children, Guillain-Barré syndrome, chronic inflammatory disseminated polyneuropathy, opsoclonus myoclonus syndrome, or Bell's palsy.

The most frequently reported adverse events after DTaP in the Vaccine Adverse Effect Reporting System (VAERS) and Vaccine Safety Datalink (VSD), two post-licensure surveillance systems, were consistent with observations from pre-licensure studies of these vaccines. When VAERS DTaP reports for each vaccine brand were compared individually with reports for all other inactivated vaccines in the VAERS database, no concerning patterns of adverse events were observed.



