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## **TETANUS**

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

*C. tetani* is a slender, gram-positive, anaerobic rod that may develop a terminal spore, giving it a drumstick appearance. The organism is sensitive to heat and cannot survive in the presence of oxygen. The spores, in contrast, are very resistant to heat and the usual antiseptics. They can survive autoclaving at 121°C for 10-15 minutes. The spores are also relatively resistant to phenol and other chemical agents.

*Clostridium tetani* produces two exotoxins, tetanolysin and tetanospasmin. The function of tetanolysin is not known with certainty. Tetanospasmin is a neurotoxin and causes the clinical manifestations of tetanus. Tetanospasmin is one of the most potent toxins known on a weight basis. 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 human.

### **Epidemiology**

The spores are widely distributed in soil and in the intestine 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.

Occurrence is 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.

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

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

The incubation period varies from 3 to 21 days, usually about 8 days. In general the further the injury site is from the central nervous system, the longer the incubation period. The shorter the incubation period, the higher the chance of death. In neonatal tetanus, symptoms usually appear from 4 to 14 days after birth, averaging about 7 days.

Almost all reported cases of tetanus are in persons who have either never been vaccinated, or who completed a primary series, but have not had a booster in the preceding 10 years. Heroin users, particularly persons who inject themselves subcutaneously, appear to be at high risk for tetanus. Quinine is used to dilute heroin and may support the growth of *C. tetani*. Neonatal tetanus is rare in the United States, with only 2 cases reported since 1989. Neither of the infants' mothers had ever received tetanus toxoid.

Among the most frequent wound types were puncture wounds, lacerations, and abrasions. The most common puncture wound is from stepping on a nail. Other puncture wounds involve barbed wire, splinters, animal or insect bites, self-piercing, and self-performed tattoos. The environment in which acute injuries occur are indoors or at home, in the yard, garden, or farm, and other outdoor locations.

## Clinical Description

*C. tetani* usually enters the body through a wound. In the presence of anaerobic (low oxygen) conditions, the spores germinate. Toxins are produced, and disseminated via blood and lymphatics. Toxins act at several sites within the central nervous system, including peripheral motor end plates, spinal cord, brain, and sympathetic nervous system. The typical clinical manifestations of tetanus are caused when tetanus toxin interferes with release of neurotransmitters, blocking inhibitor impulses. This leads to unopposed muscle contractions.

On the basis of clinical findings, three different forms of tetanus have been described.

- Local 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. Local tetanus may precede the onset of generalized tetanus, but is generally milder. Only about 1% of cases are fatal.
- Cephalic tetanus is a rare form of the disease, occasionally occurring with otitis media (ear infections) 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.
- The most common type (about 80%) of reported tetanus 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 a temperature rise of 2°-4°C above normal, sweating, elevated blood pressure, and episodic rapid heart rate. Spasms may occur frequently and last for several minutes. Spasms continue for 3-4 weeks. Complete recovery may take months.
- 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. Neonatal tetanus is common in some developing countries (estimated >215,000 deaths worldwide in 1998), but very rare in the United States.

**Complications:** Laryngospasm (spasm of the vocal cords) and/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 and/or an abnormal heart rhythm. Nosocomial infections are common because of prolonged hospitalization.

Secondary infections, which may include sepsis from indwelling catheters, hospital-acquired pneumonias, and decubitus ulcers. Pulmonary embolism is particularly a problem in drug users and elderly patients. Aspiration pneumonia is a common late complication of tetanus, found in 50%-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 (18%), and unvaccinated persons (22%). In about 20% of tetanus deaths, no obvious pathology is identified and death is attributed to the direct effects of tetanus toxin.

The death-to-case ratio has declined from 30% to approximately 10% in recent years.

### **Laboratory Tests**

There are no laboratory findings characteristic of tetanus. The diagnosis 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.

### **Treatment**

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 effect toxin bound to nerve endings. A single intramuscular dose of 3000 to 5000 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. Due to 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; proper 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 0-2 prior doses or have an uncertain history of prior doses, need tetanus immune globulin (TIG) as well as Td toxoids. This is because early doses of toxoid do not induce immunity, but only prime the immune system. The 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.

### **Surveillance**

Tetanus is a condition reportable within 1 business day of diagnosis.

### **Case Definition**

Tetanus clinical case definition Tetanus is defined by the acute onset of hypertonia or by painful muscular contractions (usually of the muscles of the jaw and neck) and generalized muscle spasms without other apparent medical cause.

Case classification, Confirmed. A clinically compatible case, as reported by a health-care professional.

### **Investigation**

- Upon receipt of a report of a case of tetanus, contact the physician and/or hospital to confirm the diagnosis. (The diagnosis is entirely clinical and does not depend upon bacteriologic confirmation).
- Determine the circumstances of injury.

- Determine the immunization status. Check health unit records of the patient, if seen through health unit clinics.

### Information to collect

The following data are epidemiologically important and should be collected in the course of case investigation. Additional information may be collected at the direction of the state health department.

- Demographic information
  - Name
  - Address
  - State of residence
  - Date of birth
  - Age
  - Sex
  - Ethnicity
  - Race
  - Occupation
- Reporting Source
  - County
  - Earliest date reported
- Clinical
  - Hospitalization and duration of stay
  - Date of onset of symptoms
  - Type of tetanus disease
  - Wound location and management
  - Complications
  - Pre-existing conditions (e.g., diabetes, chronic otitis media)
  - Outcome (case survived or died)
  - Date of death
- Treatment
  - Prophylaxis with Td and TIG
  - Date started
- Vaccine Information
  - Dates of vaccination (prior tetanus toxoid history)
  - Time since last dose of tetanus toxoid
  - Manufacturer of vaccine
  - Lot number
  - If not vaccinated, reason
- Epidemiological
  - Risk factors for disease such as history of a wound or injury, recent injection drug use, tattooing, or body piercing
  - For neonatal cases, maternal country or origin and number of years of residence in the U.S.

### **Immunization**

Tetanus toxoid was first produced in 1924. The toxoid is standardized for potency in animal tests according to Food and Drug Administration (FDA) regulations. Occasionally, potency is mistakenly equated with Lf units, which are a measure of the quantity of toxoid, not its potency in inducing protection.

There are two types of toxoid available — adsorbed (aluminum salt precipitated) toxoid and fluid toxoid. Although the rates of seroconversion are about equal, the adsorbed toxoid is preferred because the anti-toxin response reaches higher titers and is longer lasting than following the fluid toxoid. Tetanus toxoid is

available as a single antigen preparation, combined with diphtheria as pediatric DT or adult Td, and with both diphtheria toxoid and acellular pertussis vaccine as DTaP. Pediatric formulations (DT and DTaP) contain a similar amount of tetanus toxoid as adult Td, but contain 3-4 times as much diphtheria toxoid. Children younger than 7 years of age should receive either DTaP or pediatric DT. Persons 7 years of age or older should receive the adult formulation (adult Td), even if they have not completed a series of DTaP or pediatric DT. There is virtually no reason to use single antigen tetanus toxoid. Tetanus toxoid should be given in combination with diphtheria toxoid, since periodic boosting is needed for both antigens.

#### Immunogenicity And Vaccine Efficacy

After a primary series of three properly spaced doses of tetanus toxoid in persons >7 years of age and four doses in children <7 years of age, essentially all recipients achieve antitoxin levels considerably greater than the minimal protective level of 0.01 IU/ml. Efficacy of the toxoid has never been studied in a vaccine trial. It can be inferred from protective antitoxin levels that a complete tetanus toxoid series has a clinical efficacy of virtually 100%; cases of tetanus occurring in fully immunized persons whose last dose was within the last 10 years are extremely rare. Following a properly administered primary series, almost all persons develop a protective level of antitoxin. Antitoxin levels decrease with time. While some persons may be protected for life, most persons have antitoxin levels that approach the minimal protective level by 10 years after the last dose. 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 in individuals who sustain a wound that is other than clean and minor, a booster is recommended for these persons if more than 5 years have elapsed since their last dose.

#### Vaccination Schedule And Use

DTaP (diphtheria and tetanus toxoids and acellular pertussis vaccine) is the vaccine of choice for children 6 weeks through 6 years of age. The usual schedule is a primary series of 4 doses at 2, 4, 6, and 15-18 months of age. The first, second, and third doses of DTaP should be separated by a minimum of 4 weeks. The fourth dose should follow the third dose by no less than 6 months, and should not be administered before 12 months of age. If a child has a valid contraindication to pertussis vaccine, pediatric DT should be used to complete the vaccination series. If the child was less than 12 months old when the first dose of DT was administered (as DTaP or DT), the child should receive a total of four primary DT doses. If the child was 12 months of age or older at the time that the first dose of DT was administered, three doses (third dose 6-12 months after the second) completes the primary DT series. If the fourth dose of DTaP, DTP, or DT is administered before the fourth birthday, a booster dose is recommended at 4-6 years of age. The fifth dose is not required if the fourth dose was given on or after the fourth birthday. Because of waning antitoxin titers, most individuals have antitoxin levels below the optimal level 10 years after the last dose of DTaP, DTP, DT, or Td. As a result, additional booster doses of tetanus and diphtheria toxoids (as Td) are required every 10 years to maintain protective antitoxin titers. The first booster dose of Td may be given at 11-12 years of age, if at least 5 years have elapsed since the last dose of DTaP, DTP, or DT. If a dose is given sooner as part of wound management, the next booster is not needed for 10 years thereafter. More frequent boosters are not indicated and have been reported to result in an increased incidence and severity of local adverse reactions.

Td is the vaccine of choice for children 7 years and older, and for adults. A primary series is three or four doses, depending on whether the person has received prior doses of diphtheria-containing vaccine, and the age these doses were administered. The number of doses recommended for children who received one or more doses of DTP, DTaP, or DT before age 7 years is discussed above. For unvaccinated persons 7 years and older (including persons who cannot document prior vaccination), the primary series is three doses. The first two doses should be separated by at least 4 weeks, and the third dose given 6 to 12 months after the second. A booster dose of Td should be given every 10 years. Interruption of the recommended schedule or delay of subsequent doses does not reduce the response to the vaccine when the series is finally completed. There is no need to restart a series regardless of the time elapsed between doses.

Tetanus disease does not confer immunity because of the very small amount of toxin required to produce illness. Persons recovering from tetanus should begin or complete active immunization with tetanus toxoid (Td) during convalescence.

#### Adverse Reactions Following Vaccination

Local adverse reactions (e.g., erythema, induration, pain at the injection site) are common, but are usually self-limited and require no therapy. A nodule may be palpable at the injection site of adsorbed products for several weeks. Abscess at the site of injection has been reported. Fever and other systemic symptoms are not common.

Exaggerated local (Arthus-like) reactions are occasionally reported following receipt of a diphtheria-or tetanus-containing vaccine. These reactions present as extensive painful swelling, often from shoulder to elbow. They generally begin from 2 to 8 hours after injections, and are reported most often in adults, particularly those who have received frequent doses of diphtheria or tetanus toxoid. Persons experiencing these severe reactions usually have very high serum antitoxin levels; they should not be given further routine or emergency booster doses of Td more frequently than every 10 years. Less severe local reactions may occur in persons who have multiple prior boosters.

Severe systemic reactions such as generalized urticaria (hives), anaphylaxis, or neurologic complications have been reported after receipt of tetanus toxoid. A few cases of peripheral neuropathy and Guillain-Barré Syndrome (GBS) have been reported following tetanus toxoid administration. Following a recent review, the Institute of Medicine (IOM) concluded that the available evidence favors a causal relationship between tetanus toxoid and both brachial neuritis and GBS, although these reactions are very rare.

#### Contraindications And Precautions To Vaccination

A severe allergic reaction (acute respiratory distress or collapse) following a prior dose of tetanus toxoid is a contraindication to receipt of tetanus toxoid. If a generalized reaction is suspected to represent allergy, it may be useful to refer an individual for appropriate skin testing before discontinuing tetanus toxoid immunization. A moderate or severe acute illness is reason to defer routine vaccination, but a minor illness is not. If a contraindication to using tetanus toxoid-containing preparations exists, passive immunization with tetanus immune globulin (TIG) should be considered whenever an injury other than a clean minor wound is sustained.

#### Vaccine Storage And Handling

DTaP, DT (pediatric), Td, DTP/Hib, and tetanus toxoid should be stored continuously at 2° - 8°C (35° - 46°F). The vaccine may be out of refrigeration for up to 4 days, but should be refrigerated immediately when received. Freezing reduces the potency of the tetanus component.

#### **Prevention**

Because established tetanus is often fatal, even with expert treatment, prevention is of paramount importance. The two major means of preventing tetanus are immunization and wound care.

**Hospital precaution and isolation:** Standard precautions.