Tetanus

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Outline of the Talk

- History of tetanus
- Epidemiology in the United States
- Causative organism
- Pathogenesis
- Clinical features
- Complications
- Diagnosis
- Differential diagnosis
- Treatment
- Prevention
  - Prophylaxis in wound management
  - Immunization
- Neonatal tetanus
History of Tetanus
History of Tetanus

• First described by Hippocrates—a timeless human misery
History of Tetanus

1802-1812

History of Tetanus

“Opisthotonus” by Sir Charles Bell, 1809.
History of Tetanus

- Etiology discovered in 1884 by Carle and Rattone
- Produced tetanus in rabbits by injecting their sciatic nerve with pus from a fatal human tetanus case in 1884
History of Tetanus

- Kitasato in 1889 isolated the organism from a human victim, showed that it produced disease when injected into animals.
- Reported that toxin could be neutralized by specific antibodies.
History of Tetanus

• In 1897, Nocard demonstrated the protective effect of passively transferred antitoxin
• Passive immunization was used for treatment and prophylaxis during World War I
History of Tetanus

- Tetanus toxoid was developed by Descombey in 1924
- Widely used during World War II
Epidemiology of Tetanus
Tetanus Epidemiology

• Occurrence
  – Worldwide
  – Densely populated regions
  – Hot and damp climate with soil rich in organic matter

• Reservoir
  – Soil and intestine of animals and human

• Transmission
  – Contaminated wounds
  – Tissue injury
Tetanus Epidemiology

- **Temporal pattern**
  - Peak in summer or wet season

- **Communicability**
  - Not contagious from person to person
  - Only preventable disease that is infectious but not contagious
Secular trends of Tetanus in the United States
Tetanus - United States, 1947-2002

Cases

Tetanus - United States, 1980-2002
Tetanus – United States, 1980-2002

Age Distribution

Cases

0 100 200 300 400 500 600 700 800 900 1000

Age group (yrs)

<5 5-14 15-24 25-39 40+

Tetanus – United States, 1980-2002

Age Distribution

Cases

0 100 200 300 400 500 600 700 800 900 1000

Age group (yrs)

<5 5-14 15-24 25-39 40+

Age group (yrs)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;40</td>
<td>28</td>
<td>42</td>
</tr>
<tr>
<td>40+</td>
<td>72</td>
<td>58</td>
</tr>
</tbody>
</table>
FIGURE 4. Number of tetanus cases reported among persons with diabetes or injection-drug use (IDU), by age group — United States, 1998–2000
<table>
<thead>
<tr>
<th>Vaccination history</th>
<th>No. (%)</th>
<th>Time since last dose</th>
<th>Case fatality ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;10 years</td>
<td>≥10 years</td>
</tr>
<tr>
<td>0 doses</td>
<td>20 (15.4)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1 dose</td>
<td>10 (7.7)</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>2 doses</td>
<td>0 (0.0)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3 doses</td>
<td>2 (1.5)</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>≥4 doses</td>
<td>18 (13.9)</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Unknown</td>
<td>80 (61.5)</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>130 (100.0)</td>
<td>16</td>
<td>33</td>
</tr>
</tbody>
</table>

* Number of cases.
† The outcome was known for 113 of 130 cases.
§ Includes one neonatal case.
‖ Death occurred in an injection-drug user aged 55 years; 11 years since last dose.
** Includes cases with unknown total number of doses who could recall when the last dose of vaccine was received.
TABLE 2. Condition before the onset of tetanus, by acute injury status and number of cases with a history of injection-drug use (IDU) and diabetes, among 130 reported tetanus cases—United States 1998–2000

<table>
<thead>
<tr>
<th>Condition before tetanus</th>
<th>Tetanus among diabetics</th>
<th>Tetanus among IDUs</th>
<th>Other*</th>
<th>All tetanus cases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute injury</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Puncture</td>
<td>7</td>
<td>1</td>
<td>39</td>
<td>47</td>
</tr>
<tr>
<td>Laceration</td>
<td>2</td>
<td>0</td>
<td>29</td>
<td>31</td>
</tr>
<tr>
<td>Abrasion</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Crush</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Avulsion</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Compound fracture</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gunshot</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
<td><strong>1</strong></td>
<td><strong>82</strong></td>
<td><strong>94</strong></td>
</tr>
<tr>
<td><strong>No acute injury</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abscess</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Ulcer</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Gangrene</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Gingivitis</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Other infection(s)</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>No infection†</td>
<td>1</td>
<td>7</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
<td><strong>18</strong></td>
<td><strong>11</strong></td>
<td><strong>34</strong></td>
</tr>
<tr>
<td>Neonate</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Unknown injury history</strong></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16</strong></td>
<td><strong>19</strong></td>
<td><strong>95</strong></td>
<td><strong>130</strong></td>
</tr>
</tbody>
</table>

* Tetanus cases that did not occur among diabetics or injection-drug users.
† Patients without a reported injury.
FIGURE 2. Number of tetanus cases reported and average annual incidence rates, by state — United States, 1998–2000

Cases per million
- 0
- 0.01–0.14
- ≥0.015
FIGURE 3. Number of tetanus cases reported, average annual incidence rates, and survival status of patients, by age group — United States, 1998–2000
Causative agent of Tetanus
**Clostridium tetani**

- **Two forms:**
  1. **Vegetative:**
     - Slender, gram positive, nonencapsulated, motile anaerobic bacillus
     - Susceptible to bactericidal effect of heat, chemical disinfectants and antibiotics
     - Pathogenic form
  2. **Sporulated:**
     - Bulge at one end; drumstick appearance
     - Highly resistant to disinfection by chemicals or heat
Clostridium tetani - Spores & vegetative cells
Clostridium tetani

- Spores widely distributed in soil, in intestinal tract and animal feces
- Manure treated soil may contain large numbers of spore and persist for months to years
- In agricultural settings, adults may harbor organism
- Spores can be found on skin surfaces and in contaminated heroin
**Clostridium tetani**

- Spores remains nonpathogenic in soil or contaminated tissues until conditions are favorable for transformation into vegetative form
- Transformation occurs due to locally decreased oxygen reduction potential in the ff:
  - Devitalized tissue w/ foreign body
  - Trauma (crushed injury)
  - Suppurative infection
Tetanus Toxins

• Germination of spores and production of toxins under anaerobic conditions:
  1. Tetanolysin:
     • Potentiates infection but not involved in pathogenesis
     • Its role not known with certainty
  2. Tetanospasmin: (tetanus toxin)
Tetanus Toxins

Tetanospasmin: (tetanus toxin)

- Potent neurotoxin released with growth of *C. tetani* at site of infection
- One of the most potent toxins known on a weight basis
- Estimated minimum human lethal dose is 2.5 ng/kg
- Causes clinical tetanus
Pathogenesis of Tetanus
**Tetanus Pathogenesis**

*C. tetani* enters body thru a wound → in anaerobic conditions spores germinate → toxins produced → disseminated via blood and lymphatics → acts at several sites:

- Central nervous system
- Spinal cord
- Brain
- Sympathetic nervous system
Mode of Action of the Tetanus Toxin

• Tetanus exotoxin binds to inhibitory interneurons of spinal cord → blocks release of inhibitors.
• Inhibitors allow contracted muscles to relax by stopping excitatory neurons from releasing acetylcholine that is responsible for muscle contraction.
Normal
Glycine (G) release stops acetylcholine (A) release and allows relaxation of muscle

Tetanus
Tetanus toxin binds to inhibitory interneurons, preventing release of G and relaxation of muscle
Normal
Acetylcholine (A) induces contraction of muscle fibers

Botulism
Botulinum toxin, ▲, blocks release of A, inhibiting contraction
TETANUS

NORMAL

BOTULISM

TETANUS

flaccid

spastic
Clinical Manifestation of Tetanus
Tetanus Clinical Features

- Incubation period: 8 days (range= 3-21 days)
- The further the injury site from the CNS, the longer the incubation period
- The shorter the incubation period, the higher the chance of death
- Four clinical forms:
  - Localized (uncommon)
  - Cephalic (rare)
  - Generalized (most common)
  - Neonatal
Tetanus Clinical Features

• Localized tetanus:
  – Unusual presentation
  – Persistent contraction of muscle in same anatomic area as the injury
  – Contractions may persist for many weeks before subsiding
  – May precede the onset of generalized tetanus
  – Only 1% of cases are fatal
A preschool-aged boy with localized tetanus secondary to the parent attempting to drain an impetigo lesion with a mesquite thorn contaminated with tetanus spores.
Tetanus Clinical Features

• Cephalic tetanus (rare)
  – Rare presentation
  – Special form of localized disease affecting the cranial nerve musculature
  – Occurs after injury to scalp, eyes, face, ear or neck, conjunctiva
  – Clinical manifestations 1-2 days after injury:
    • Facial palsy
    • Dysphagia
    • Paralysis of extraocular muscles
  – Outcome is variable
Tetanus Clinical Features

• Generalized tetanus:
  – Most commonly recognized form
  – Presents with descending pattern
    • Masseter muscle rigidity - trismus (lockjaw)
    • Risus sardonicus (increased tone in orbicularis oris muscle)
    • Stiffness of neck
    • Difficulty swallowing
    • Abdominal muscle rigidity
    • Generalized spasms resembles decorticate posturing- opisthotonic posturing with flexion of arms and extension of legs
Tetanus Clinical Features

- **Generalized tetanus:**
  - Patient does not lose consciousness and experiences severe pain during each spasm
  - Spasms triggered by sensory stimuli
  - Spasms continue for 2-3 weeks; (time required to complete transport of toxin already intra-axonal) after antitoxin is given
  - If antitoxin not given, complete recovery take months (until cessation of production/binding of tetanospasmin and formation of new neuromuscular junctions)
Child has painful muscle contractions from tetanus: trismus, risus sardonicus, generalized spasms
This patient has opisthotonus secondary to severe tetanus head and heels are bent backward and the body is bowed forward
Complications of Tetanus
## Complications of Tetanus

<table>
<thead>
<tr>
<th>Complication</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiomyopathy</td>
<td>Direct toxic effect</td>
</tr>
<tr>
<td>Phrenic nerve palsy</td>
<td>Direct toxic effect</td>
</tr>
<tr>
<td>Laryngeal nerve palsy</td>
<td>Direct toxic effect</td>
</tr>
<tr>
<td>Respiratory compromise</td>
<td>Secondary to spasms</td>
</tr>
<tr>
<td>Rhabdomyolysis</td>
<td>Secondary to spasms</td>
</tr>
<tr>
<td>Myositis ossificans circumspecta</td>
<td>Secondary to spasms</td>
</tr>
<tr>
<td>Vertebral compression fracture</td>
<td>Secondary to spasms</td>
</tr>
<tr>
<td>Hypoxic cerebral injury</td>
<td>Secondary to respiratory compromise</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>Secondary to rhabdomyolysis</td>
</tr>
<tr>
<td>Psychologic</td>
<td>Most prominent after recovery</td>
</tr>
</tbody>
</table>
Complications of Tetanus

- Hypertension
  - due to hyperactivity of autonomic nervous system
- Nosocomial infections
- Pulmonary embolism
  - Drug users and elderly
- Aspiration pneumonia
- Death (11%)
  - >60 years (18%)
  - Unvaccinated persons (22%)
Diagnosis of Tetanus
Diagnosis of Tetanus

- High index of suspicion
- History (crush injury and soil contamination = key elements)
- In US, most cases occur after puncture wounds (in door/out door), farming or gardening or use of illicit drugs
Diagnosis of Tetanus

• No laboratory findings characteristic of tetanus

• \textit{C. tetani}
  – recovered 30\% of wound
  – can be isolated from asymptomatic patients

• Laboratory confirmatory test:
  – demonstration of toxin production in mice
Differential Diagnosis of Tetanus
Differential Diagnosis of Tetanus

• Encephalitis, meningitis, seizures
• Dystonic reaction to neuroleptics:
  – Posture involves lateral neck turning
  – Treatment with anticholinergic agents
• Strychnine toxicity:
  – Truly mimics tetanus
  – Should be considered when tetanus is suspected and vise versa
  – Antagonize glycine
  – Biochemical analysis of blood and urine
  – Initial treatment similar to tetanus
Strychnine

- White, odorless, bitter crystalline powder
- Can be taken by mouth; inhaled or mixed in a solution and given intravenously
- Antagonize glycine
- Source: Strychnos nux vomica
- Plant found in southern Asia (India, Sri Lanka, and East Indies) and Australia
Strychnine

- In the past, available in pill form
- Used to treat many human ailments
- Today used primarily as pesticide to kill rats.
- Uncommonly is found mixed with “street” drugs such as LSD, heroin, and cocaine
Treatment of Tetanus
Treatment of Tetanus

• Three goals of management:
  – Neutralize the toxin
  – Eradicate *C. tetani*
  – Provide supportive care and maintain adequate airway and nutrition
Treatment of Tetanus

- **Human tetanus immune globulin (TIG):**
  - Single dose 3,000-6,000 units IM
  - Neutralizes circulating tetanospasmin that has not entered the nervous system

- **Local wound care:**
  - Remove foreign bodies
  - Irrigate wound vigorously
  - Debridement of wound to remove devitalized tissue
Treatment of Tetanus

• Eradicate *C. tetani*
  – Oral or IV metronidazole 30 mg/kg day divided Q 6 hours for 10-14 days (DOC)
  – Penicillin G 100,000 units /kg/day divided every 4-6 hrs x 10-14 days (alternative)
Treatment of Tetanus

• Provide supportive care, maintain adequate airway and nutrition:
  – Sedation
  – Minimize fatal spasms over prolonged period until new presynaptic nerve ending generated:
    • Meticulous nursing care in the ICU with minimum stimulation
    • Noise-free, darkened room, monitors silenced
  – Benzodiazepine to control spasm and decrease rigidity
  – Labetalol for sympathetic hyperactivity (hypertension)
Treatment of Tetanus

• Tetanus disease does not confer immunity because of very small amount of toxin required to produce illness
• Patients recovering from tetanus should begin or complete active immunization with tetanus toxoid during convalescence
Prevention of Tetanus
Prevention of Tetanus

- Wound management

- Routine immunization
Table 3.61. Guide to Tetanus Prophylaxis in Routine Wound Management

<table>
<thead>
<tr>
<th>History of Absorbed Tetanus Toxoid (Doses)</th>
<th>Clean, Minor Wounds</th>
<th>All Other Wounds¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Td²</td>
<td>TIG³</td>
</tr>
<tr>
<td>&lt;3 or unknown</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>≥3⁴</td>
<td>No⁵</td>
<td>No</td>
</tr>
</tbody>
</table>

Td indicates adult-type diphtheria and tetanus toxoids vaccine; TIG, Tetanus Immune Globulin (human).

¹ Such as, but not limited to, wounds contaminated with dirt, feces, soil, and saliva; puncture wounds; avulsions; and wounds resulting from missiles, crushing, burns, and frostbite.

² For children younger than 7 years of age, diphtheria and tetanus toxoids and acellular pertussis (DTaP) vaccine is recommended; if pertussis vaccine is contraindicated, diphtheria and tetanus toxoids (DT) vaccine is given. For people 7 years of age or older, Td vaccine is recommended.

³ Equine tetanus antitoxin should be used, if available, when TIG is not available.

⁴ If only 3 doses of fluid toxoid have been received, a fourth dose of toxoid, preferably an adsorbed toxoid, should be given. Although licensed, fluid tetanus toxoid rarely is used.

⁵ Yes, if more than 10 years since last dose.

⁶ Yes, if more than 5 years since last dose. More frequent boosters are not needed and can accentuate adverse effects.
Tetanus Toxoid

- Formalin-inactivated tetanus toxin
- Schedule: Three or four doses +
- Booster: Booster every 10 years
- Efficacy: Approximately 100%
- Duration: Approximately 10 years
- Should be administered with diphtheria toxoid as DTaP, DT, or Td
DTaP, DT, and Td

Diphtheria  Tetanus

DTaP, DT  7-8 Lf units  5 Lf units
Td (adult)  2 Lf units  5 Lf units

- Pertussis vaccine and pediatric DT used through age 6 years
- Adult Td used for persons 7 years and older.
## Routine DTaP Primary Vaccination Schedule

<table>
<thead>
<tr>
<th>Dose</th>
<th>Age</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary 1</td>
<td>2 months</td>
<td>---</td>
</tr>
<tr>
<td>Primary 2</td>
<td>4 months</td>
<td>4 wks</td>
</tr>
<tr>
<td>Primary 3</td>
<td>6 months</td>
<td>4 wks</td>
</tr>
<tr>
<td>Primary 4</td>
<td>15-18 months</td>
<td>6 mos</td>
</tr>
</tbody>
</table>
Routine DTaP Schedule
Children <7 years of age

Booster Doses

- 4-6 years, before entering school
- 11-12 years of age if 5 years since last dose (Td)
- Every 10 years thereafter (Td)
Children Who Receive DT

• The number of doses of DT needed to complete the series depends on the child’s age at the first dose:
  • if first dose given at <12 months of age, 4 doses are recommended
  • if first dose given at ≥12 months, 3 doses complete the primary series
### Routine Td Schedule

Unvaccinated Persons

> 7 Years of Age

<table>
<thead>
<tr>
<th>Dose</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary 1</td>
<td>---</td>
</tr>
<tr>
<td>Primary 2</td>
<td>4 wks</td>
</tr>
<tr>
<td>Primary 3</td>
<td>6-12 mos</td>
</tr>
</tbody>
</table>

Booster dose every 10 years
Diphtheria and Tetanus Toxoids

Adverse Reactions

- Local reactions (erythema, induration)
- Exaggerated local reactions (Arthus-type)
- Fever and systemic symptoms not common
- Severe systemic reactions rare
Diphtheria and Tetanus Toxoids
Contraindications and Precautions

- Severe allergic reaction to vaccine component or following prior dose
- Moderate or severe acute illness
Neonatal Tetanus
Neonatal Tetanus

- Described in old testament “7th day death”
- Generalized tetanus in newborn infant
- Infant born to inadequately immunized mothers without protective passive immunity
- Originate from infection of umbilical stump due to:
  - Poor obstetric procedure
  - Inadequate post-natal care
  - Cultural practices (application of cow dung or soil to umbilical stump in rural Pakistan)
Neonatal Tetanus

- **IP**: 7 days (3-14 days)
- **Clinical Manifestations**:
  - Weakness and inability to suck
  - Tetanic spasms, rigidity, opisthotonus
- **High fatality rate (>90%) without therapy**:
  - Apnea in first week
  - Septicemia in 2nd week
  - Other: pneumonia, CNS hge., laryngeal spasms
- **Poor prognosis**:
  - risus sardonicus, < 10 days old, delayed in seeking medical care
Baby has neonatal tetanus with complete rigidity
Epidemiology of Neonatal Tetanus
Countries carrying the global neonatal tetanus burden

<table>
<thead>
<tr>
<th>Country</th>
<th>Estimated number of deaths, 1990</th>
<th>Mortality rate per 1000 live births, 1990</th>
<th>Estimated number of deaths, 1999</th>
<th>Mortality rate per 1000 live births, 1999</th>
<th>% change mortality rate, 1990-1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>77,700</td>
<td>3.0</td>
<td>48,600</td>
<td>2.0</td>
<td>-34</td>
</tr>
<tr>
<td>Nigeria</td>
<td>23,400</td>
<td>5.3</td>
<td>34,600</td>
<td>6.8</td>
<td>28</td>
</tr>
<tr>
<td>Pakistan</td>
<td>36,300</td>
<td>7.0</td>
<td>21,600</td>
<td>4.1</td>
<td>-42</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>14,800</td>
<td>6.4</td>
<td>13,400</td>
<td>4.5</td>
<td>-30</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>38,600</td>
<td>9.9</td>
<td>10,400</td>
<td>3.1</td>
<td>-69</td>
</tr>
<tr>
<td>Congo, Dem. Rep.</td>
<td>7,200</td>
<td>4.0</td>
<td>10,000</td>
<td>4.6</td>
<td>14</td>
</tr>
<tr>
<td>Somalia</td>
<td>6,500</td>
<td>15</td>
<td>8,800</td>
<td>16.5</td>
<td>10</td>
</tr>
<tr>
<td>China</td>
<td>75,700</td>
<td>3.2</td>
<td>8,600</td>
<td>0.4</td>
<td>-87</td>
</tr>
<tr>
<td>Total</td>
<td>280,000</td>
<td></td>
<td>156,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>other</td>
<td>190,000</td>
<td></td>
<td>59,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>global total</td>
<td>470,000</td>
<td></td>
<td>215,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

73% of the developing world's estimated NT deaths are found in 8 countries:

- India 23%
- Nigeria 16%
- Pakistan 10%
- Ethiopia 6%
- Bangladesh 5%
- DR Congo 5%
- Somalia 4%
- China 4%
- Other 27%

Source: UNICEF, 2001
## Countries carrying the global neonatal tetanus burden

<table>
<thead>
<tr>
<th>Country</th>
<th>Estimated number of deaths, 1990</th>
<th>Mortality rate per 1000 live births, 1990</th>
<th>Estimated number of deaths, 1999</th>
<th>Mortality rate per 1000 live births, 1999</th>
<th>% change mortality rate, 1990-1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>77,700</td>
<td>3.0</td>
<td>48,600</td>
<td>2.0</td>
<td>-34</td>
</tr>
<tr>
<td>Nigeria</td>
<td>23,400</td>
<td>5.3</td>
<td>34,600</td>
<td>6.8</td>
<td>28</td>
</tr>
<tr>
<td>Pakistan</td>
<td>36,300</td>
<td>7.0</td>
<td>21,600</td>
<td>4.1</td>
<td>-42</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>14,800</td>
<td>6.4</td>
<td>13,400</td>
<td>4.5</td>
<td>-30</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>38,600</td>
<td>9.9</td>
<td>10,400</td>
<td>3.1</td>
<td>-69</td>
</tr>
<tr>
<td>Congo, Dem. Rep.</td>
<td>7,200</td>
<td>4.0</td>
<td>10,000</td>
<td>4.6</td>
<td>14</td>
</tr>
<tr>
<td>Somalia</td>
<td>6,500</td>
<td>15</td>
<td>8,800</td>
<td>16.5</td>
<td>10</td>
</tr>
<tr>
<td>China</td>
<td>75,700</td>
<td>3.2</td>
<td>8,600</td>
<td>0.4</td>
<td>-87</td>
</tr>
<tr>
<td>Total</td>
<td>280,000</td>
<td></td>
<td>156,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>other</td>
<td>190,000</td>
<td></td>
<td>59,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>global total</td>
<td>470,000</td>
<td></td>
<td>215,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Progress in countries with more than 6,000 deaths in 1990
Reduction in the number of deaths, 1990-2000

- India
- China
- Bangladesh
- Pakistan
- Nigeria
- Indonesia
- Ethiopia
- Uganda
- DR Congo
- Nepal
- Somalia
- Viet Nam
- Brazil

- Estimated number of deaths 1990
- Estimated number of deaths 1999
1999: 289,000 cases of neonatal tetanus annually resulting in the death of 215,000 infants
Efforts to eliminate neonatal and maternal tetanus are still ongoing; Nigerian women receive the tetanus vaccine, which will protect the children they bear.
MNT Elimination Status as of December 2002

Source: WHO/UNICEF MNT collected data 2002
As of 24 March 2003
UNICEF/WHO: New Goal
Maternal and Neonatal Tetanus Elimination
by 2005
Maternal and Neonatal Tetanus Elimination Strategies

• Identify high risk districts/areas
• 3 TT in high risk districts/areas
• Ensuring high TT vaccination coverage for pregnant women through:
  – Routine immunization for women and children
• Promotion of clean delivery practices
• Neonatal tetanus surveillance
High or low risk for NT

High Risk

Is reported NT rate < 1/1000 LB in district? NO

Is district NT surveillance sensitive? YES

Is reported district clean delivery coverage ≥ 70% NO

Is TT2 coverage ≥ 80% among pregnant women (or among women of childbearing age in past 5 years)? NO

Low Risk

YES

Note: LB: Live births
## Tetanus toxoid - immunization schedule for women of childbearing age

<table>
<thead>
<tr>
<th>Dose</th>
<th>Administration</th>
<th>Protection (approximately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT 1</td>
<td>At first contact during maternal care, or as early as possible during pregnancy</td>
<td>None</td>
</tr>
<tr>
<td>TT 2</td>
<td>At least four weeks after TT1</td>
<td>1-3 years</td>
</tr>
<tr>
<td>TT 3</td>
<td>At least six months after TT2</td>
<td>5 years</td>
</tr>
<tr>
<td>TT 4</td>
<td>At least one year after TT 3 or during subsequent pregnancy</td>
<td>10 years</td>
</tr>
<tr>
<td>TT 5</td>
<td>At least one year after TT 4 or during subsequent pregnancy</td>
<td>A woman's immunity and her ability to confer short-term immunity to her newborn will last throughout her reproductive life</td>
</tr>
</tbody>
</table>

Source: WHO, 2001
A health worker gives a woman a tetanus toxoid vaccination in Unguwan-Kunda Durum
A frightened farmer carries his wife, stricken with tetanus, to the People's Health Centre in Savar, Bangladesh.
Questions
A 16-year-old boy cut his hand while slicing tomatoes at a fast-food restaurant. His mother is contacted by phone and states that he has had no immunizations since the age of 5, but that his immunizations were complete up to that age.

Of the following, the MOST appropriate choice of tetanus prophylaxis for this patient is:

A. adult tetanus and diphtheria toxoid (Td)
B. diphtheria and tetanus toxoid and pertussis vaccine (DTP)
C. none
D. tetanus immune globulin (TIG)
E. Td and TIG
Table 3.61. Guide to Tetanus Prophylaxis in Routine Wound Management

<table>
<thead>
<tr>
<th>History of Absorbed Tetanus Toxoid (Doses)</th>
<th>Clean, Minor Wounds</th>
<th>All Other Wounds¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Td²</td>
<td>TIG³</td>
</tr>
<tr>
<td>&lt;3 or unknown</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>≥3⁴</td>
<td>No⁵</td>
<td>No</td>
</tr>
</tbody>
</table>

Td indicates adult-type diphtheria and tetanus toxoids vaccine; TIG, Tetanus Immune Globulin (human).

¹ Such as, but not limited to, wounds contaminated with dirt, feces, soil, and saliva; puncture wounds; avulsions; and wounds resulting from missiles, crushing, burns, and frostbite.

² For children younger than 7 years of age, diphtheria and tetanus toxoids and acellular pertussis (DTaP) vaccine is recommended; if pertussis vaccine is contraindicated, diphtheria and tetanus toxoids (DT) vaccine is given. For people 7 years of age or older, Td vaccine is recommended.

³ Equine tetanus antitoxin should be used, if available, when TIG is not available.

⁴ If only 3 doses of fluid toxoid have been received, a fourth dose of toxoid, preferably an adsorbed toxoid, should be given. Although licensed, fluid tetanus toxoid rarely is used.

⁵ Yes, if more than 10 years since last dose.

⁶ Yes, if more than 5 years since last dose. More frequent boosters are not needed and can accentuate adverse effects.
Clostridium tetani is a spore-forming, anaerobic, gram-positive rod that is found worldwide in soil and human and animal feces. It produces a potent exotoxin that causes severe generalized muscle spasms. Tetanus is not transmissible from person to person, and cases are rare in persons who have adequate, up-to-date immunization. Because immunization with tetanus toxoid does not confer lifelong immunity, booster doses are recommended at 10-year intervals.

The need for an additional booster dose of tetanus toxoid or passive immunization with tetanus immune globulin at the time of an injury is determined by the nature of the wound and the patient’s prior immunization history. Those who have received at least three doses of tetanus toxoid, with the last being within the preceding 10 years, do not require additional protection for a clean, minor wound. For wounds that are contaminated with dirt, feces, soil, or saliva or that result from puncture wounds, frostbite, crush injuries, or burns, an additional dose of tetanus toxoid should be administered unless the last immunization was within 5 years. For children older than 7 years of age, tetanus and diphtheria toxoid (Td) is administered to maintain adequate diphtheria and tetanus immunity. For children younger than 7 years of age who need a booster injection, diphtheria and tetanus toxoids and acellular pertussis vaccine (DTaP) or diphtheria and tetanus toxoid and pertussis vaccine (DTP) is recommended.

Tetanus immune globulin is recommended only for contaminated wounds in patients who have received fewer than three doses of tetanus toxoid or in whom immunization status is unknown. Tetanus toxoid also should be administered. Tetanus immune globulin is not indicated for clean, minor wounds regardless of immunization history.

Unnecessary boosters of tetanus toxoid should be avoided because they may be associated with more severe reactions, including Arthus-type hypersensitivity reactions and high fever.
A 12-year-old boy cut his leg on an old ax that was in a storage shed. Review of his medical record reveals that he received five doses of diphtheria and tetanus toxoids and whole-cell pertussis vaccine absorbed (DTP); the last dose was administered when he was 4 years old. You clean and disinfect the wound. Of the following, your BEST management would be to administer

A. DTP
B. DTP and tetanus immune globulin (TIG)
C. adult tetanus toxoid and diphtheria toxoid (Td)
D. Td and TIG
E. no additional doses of vaccine or immune globulin
### Table 3.61. Guide to Tetanus Prophylaxis in Routine Wound Management

<table>
<thead>
<tr>
<th>History of Absorbed Tetanus Toxoid (Doses)</th>
<th>Clean, Minor Wounds</th>
<th>All Other Wounds&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Td&lt;sup&gt;2&lt;/sup&gt;</td>
<td>TIG&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>&lt;3 or unknown</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>≥3&lt;sup&gt;4&lt;/sup&gt;</td>
<td>No&lt;sup&gt;5&lt;/sup&gt;</td>
<td>No</td>
</tr>
</tbody>
</table>

Td indicates adult-type diphtheria and tetanus toxoids vaccine; TIG, Tetanus Immune Globulin (human).

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

2. For children younger than 7 years of age, diphtheria and tetanus toxoids and acellular pertussis (DTaP) vaccine is recommended; if pertussis vaccine is contraindicated, diphtheria and tetanus toxoids (DT) vaccine is given. For people 7 years of age or older, Td vaccine is recommended.

3. Equine tetanus antitoxin should be used, if available, when TIG is not available.

4. If only 3 doses of fluid toxoid have been received, a fourth dose of toxoid, preferably an adsorbed toxoid, should be given. Although licensed, fluid tetanus toxoid rarely is used.

5. Yes, if more than 10 years since last dose.

6. Yes, if more than 5 years since last dose. More frequent boosters are not needed and can accentuate adverse effects.
The boy in the vignette cut his leg on an ax that could be contaminated with dirt, feces, saliva, and rust. He is at risk for developing tetanus from infection with Clostridium tetani. Because his last tetanus immunization was given more than 5 years ago, he requires a booster vaccine with adult tetanus toxoid and diphtheria toxoid (Td). He does not require tetanus immune globulin (TIG) because he completed his primary series and received two booster doses. If he had not injured his leg at this point, he would be due for the next booster immunization when he reached 14 years of age, which would be 10 years after receiving his last dose.

Diphtheria and tetanus toxoids and whole-cell pertussis vaccine absorbed (DTP), the form given to infants and preschoolers, is not used in children older than 7 years because they do not require pertussis vaccine or the higher level of diphtheria toxoids. Adult Td is used instead because fewer adverse reactions have been reported. Diphtheria and tetanus toxoids combined with acellular pertussis vaccine (DTaP) is administered frequently to young children, but it has not been recommended for adolescents or adults.

Neonatal tetanus, a common cause of neonatal mortality but rare in the United States, arises from contamination of the umbilical stump. Infants can develop trismus and severe muscular spasms from the neurotoxin produced by C tetani.
A 9-year-old boy stepped on a nail, which penetrated his sneaker. Four days later, he began limping and developed a fever of 38.5°C (101.3°F). Physical examination reveals swelling and erythema of the affected foot; there is no evidence of lymphangitis. He received a tetanus booster 1 year ago.

Of the following, the MOST appropriate initial management of this child is to:

A. administer adult strength diphtheria and tetanus toxoids (dT) vaccine
B. administer oral penicillin until he becomes afebrile
C. aspirate the wound for culture and withhold antibiotic treatment pending results
D. debride the soft tissue and give broad-spectrum parenteral antibiotics pending cultures
E. flush the wound with saline and apply a topical antibiotic
The child presented in the vignette has findings suggestive of secondary infection after stepping on a nail. Typically, a patient experiences early improvement in pain and swelling after the puncture wound occurs, only to have the symptoms recur or worsen several days later. Puncture wounds of the foot through soft-soled shoes are associated with osteochondritis, an inflammation of the cartilage and the small bones and joints of the foot. Pseudomonas aeruginosa frequently has been isolated from the soles of such shoes. Initial laboratory tests in this situation should include a complete blood count, an erythrocyte sedimentation rate, and appropriate radiographic studies of the foot. Deep aspiration of the wound should be performed to culture for aerobic and anaerobic organisms, infected spaces should be vigorously debrided and drained, and broad-spectrum parenteral antibiotics should be started empirically until culture results are available. If osteomyelitis is suspected, a radionuclide bone scan may delineate the extent and location of infection before plain radiographs show bony changes. Because the boy's tetanus immunization status is up to date, he does not require inoculation with adult strength diphtheria and tetanus toxoids (dT) vaccine at this time. Neither topical antibiotics nor oral penicillin would provide adequate coverage for puncture wounds of the foot. A parenteral penicillinase-resistant penicillin (eg, ticarcillin-clavulanate) alone or in combination with an aminoglycoside or a cephalosporin (eg, ceftazidime), which has activity against Pseudomonas species, would be the best choice for initial therapy. If thorough surgical debridement of an infection of the foot has been performed and Pseudomonas identified as the causative agent, 7 to 10 days of antibiotic therapy appears to be adequate; most other bone or joint infections require treatment for a minimum of 21 days.
Thank You