Anthrax: An Epidemiologic Perspective

Denise Dietz
Public Health Epidemiologist
Outline

- Overview of anthrax
- Explain different types of anthrax
- Clinical
- Why a good weapon
- Epidemiology
Bacillus anthracis

- Bacteria implicated in 2001 biological attack
- Overall, 22 persons sickened
  - 11 inhalation anthrax
  - 11 cutaneous anthrax
- 5 deaths (23%)
  - All inhalation
  - About half of inhalation cases
Epi Curve of Anthrax Attacks

Actual 2001 Anthrax Attack Epi Curve

Note: arrows indicate inhalation anthrax, based on 5 letters sent
What is Anthrax?

- Bacteria
  - Soil
  - Usual route through infected animals
- Spore forming
- Types:
  - Inhalation
  - Cutaneous
  - Gastrointestinal
- Incubation period 1-7 days (up to 60 has been shown; 43 days in USSR)
Inhalation Anthrax
Inhalation Anthrax: Pathway

**Deposition** in alveolar space

→ Macrophage ingestion

→ Transport to mediastinal lymph nodes

→ **Germination**

→ **Replication/Toxin Release** = hemorrhage, edema and necrosis
Inhalation Anthrax: Clinical Progression

- **Stage 1**
  - Lasts hours to a few days
  - “non-specific” symptoms including
    - Fever
    - Fatigue, malaise
    - Cough
    - Vomiting
    - Sweating, chills
    - Shortness of breath (dyspnea)
Inhalation Anthrax: Clinical Progression

- **Stage 2**
  - Develops abruptly
  - Symptoms include
    - Sudden fever
    - Shortness of breath (dyspnea)
    - Diaphoresis (excessive sweating)
    - Shock
    - Stridor (high pitched sound resulting from turbulent air flow in the upper airway)
  - X-ray and chest computed tomographic (CT) abnormalities
    - Mediastinal widening, infiltrates, pleural effusions
Chest X-Ray of 2001 Inhalation Anthrax

Day 6 of clinical course

Died
Inhalation Anthrax: Treatment

- Animal experiments suggest critical threshold for treatment
- In 2001, all four patients exhibiting signs of fulminant (sudden/severe) illness prior to antibiotics expired
- Treatment with ciprofloxacin or doxycycline
Cutaneous Anthrax
Cutaneous Anthrax: Transmission

- Contact with contaminated skins, wool or hides, or products made from these
- Contact with tissues of animals that are clinically ill or dead from anthrax
- Contact with soil contaminated with spores or contaminated bone meal used in gardening
Cutaneous Anthrax: Pathway

Deposition on skin

Germination

Replication/Toxin Release = hemorrhage, edema and necrosis
Cutaneous Anthrax: Clinical Progression

- Local Edema
- Ulcer forms (Day 2)
- Small vesicles appear discharging clear or serosanguinous fluid - containing organism
- Black Eschar develops, dries up, and falls off within 1-2 weeks
- Systemic symptoms may occur
Cutaneous Anthrax: Treatment

- Antibiotic treatment is warranted
  - Mortality rate 20% untreated
  - Mortality rare among those treated
- Ciprofloxacin or Doxycycline
Gastrointestinal Anthrax
Gastrointestinal Anthrax: Pathway

**UPPER GI**
- Deposition on oral cavity
  - Germination
  - Replication/Toxin Release = hemorrhage, edema and necrosis

**LOWER GI**
- Deposition in terminal ileum or cecum
  - Germination
  - Replication/Toxin Release = hemorrhage, edema and necrosis
## GI Anthrax: Clinical Progression

<table>
<thead>
<tr>
<th>UPPER GI</th>
<th>LOWER GI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral or Esophageal Ulcer</td>
<td>Nausea</td>
</tr>
<tr>
<td>Regional Lymphadenopathy</td>
<td>Vomiting</td>
</tr>
<tr>
<td>Edema</td>
<td>Malaise</td>
</tr>
<tr>
<td>Sepsis</td>
<td>Bloody Diarrhea</td>
</tr>
<tr>
<td></td>
<td>Acute Abdominal Pain</td>
</tr>
</tbody>
</table>

Day 9
Gastrointestinal Anthrax: Treatment

- Fewer studies
- Anticipated case fatality rate 4 - 12%
- Antibiotics recommended – ciprofloxacin or doxycycline
Why Weaponize?

Working Group on Civilian Biodefense ranked bacillius anthracis as one of the top organisms with the ability to cause disease and deaths in sufficient numbers or to gravely impact a city or region.
# Why Weaponize?

<table>
<thead>
<tr>
<th>Optimal Characteristics</th>
<th>Anthrax</th>
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<tbody>
<tr>
<td>Living (can replicate)</td>
<td>Bacterium</td>
</tr>
<tr>
<td>High Stability</td>
<td>Spores</td>
</tr>
<tr>
<td>Highly Virulent</td>
<td>LD$_{50}$ ~2,500-55,000</td>
</tr>
<tr>
<td>Quick Incubation</td>
<td>1-7 days</td>
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<tr>
<td>Dissemination Efficient</td>
<td>Aerosol (40-60%)</td>
</tr>
</tbody>
</table>

- √ indicates that Anthrax has the characteristic.
Weaponized Anthrax

- Powder
- High spore concentration
- Uniform particle size
- Low electrostatic charge
- Treated to reduce clumping
Epidemiology of Anthrax

- Overall, not common
- Animal vaccination programs available
- Spores remain prevalent in soil
  - GI anthrax
    - Reports mostly from Asia and Africa
    - Mostly from undercooked food
  - Cutaneous
    - Most common out of three
    - US cases = 224 1944-1994, one in 2000
  - Inhalation
    - US cases = 18 from 1890-1976
    - Most US cases involved with goat hair/wool/tannery; 2 lab workers
Anthrax & Bioterrorism

- One case of any type of anthrax is “red flag” and is immediately reportable to local or state health department
- Inhalation anthrax report of great concern
- Gastrointestinal and cutaneous anthrax necessitates immediate r/o of natural cause
“Getting the Call”

- Immediately reportable confirmed or suspected anthrax
- Clinical and Microbiological support
  - Different species of bacillius
  - Gram positive, non-motile, blood agar
- Investigation begins
  - Most written recommendations are based on inhalation attack
Epidemiology Investigation

- Demographics
- Travel History during Incubation Period
- Food History for possible GI anthrax
- Any other known cases
  - Links to residency, workplace, school, vacation, etc.
- Environmental Testing
- Determination of prophylaxis – Prophylaxis is indicated for persons exposed to an airspace contaminated with *B. anthracis*.
  - Ciprofloxacin, doxycycline, and penicillin G
  - 60 days
Summary

- Inhalation anthrax most probable for attack
  - Ability to spread easily
  - High virulence
- Any report of anthrax requires investigation
- If treated early enough, antibiotics can help clinical course
- Prophylaxis is available for those in airspace - 60 days!


