Bioterrorist Threats: Sources, Recognition, & Safety

Arthur Jones, EdD, RRT

This Presentation is Approved for 1 CRCE Credit Hour

Learning Objectives

- Describe the etiology, manifestations, management, & safety precautions related to likely bioterrorist threats

Anthrax

History

- Book of Exodus: 5th & 6th plagues of Egypt (boils)
- 1600s: "Black Bane" kills cattle in Europe
- 1880: Immunization of cattle
- 1915: First used as a bioweapon - against cattle
- 1950s-60s: U.S. develops bioweapons

- 1969: U.S. ends bioweapons program
- 1970: Anthrax vaccine is FDA approved
- 1972: International convention outlaws biological weapons
- 1995: Iraq admits to producing 8,500 L of anthrax weapon
- 2001: Letter containing anthrax is mailed to NBC

Etiology

- Causative organism: bacillus anthracis
  - Gram-positive, spore-forming rod
  - Spore-forming ➔ very tough organism
  - Occurs globally, esp. in developing countries
  - Primarily infects herbivores
  - Produces lethal toxin
**Etiology**

- Bacillus anthracis

**Routes for Transmission**

- Cutaneous: most common
  - Cutaneous: ingestion of poorly cooked meat from infected animals
  - Inhalation of dust that contains spores - woolsorter’s disease

**Cutaneous Anthrax**

- Etiology & pathogenesis
  - Introduced via skin or mucus membrane through cut or abrasion
  - Spores germinate & multiply
- Manifestations: skin lesion
  - Develops 12 - 36 H after infection
  - Resembles bug or spider bite
  - Black eschar develops

**Gastrointestinal Anthrax**

- Manifestations: inflammation of GI tract
  - Nausea
  - Hematemesis
  - Fever
  - Acute abdomen - abdominal pain
  - Severe diarrhea
  - Sepsis
- High mortality rate

See links below to view more cutaneous anthrax
Inhalational (Pulmonary) Anthrax

- Etiology: inhalation of spores
  - Special processing for deposition
  - 1 - 5 micron
  - Too large: upper airway deposition
  - Too small: exhaled

- Incubation period: generally 3-5 D, depends on germination rate

- Manifestations - early
  - Fever, chills
  - Dyspnea
  - Cough
  - Headache
  - Nausea & vomiting
  - Chest pain

- Manifestations: fulmination
  - Fever
  - Dyspnea
  - Stridor: mediastinal enlargement
  - Diaphoresis
  - Shock
  - Hemorrhagic meningitis: delirium
  - Hypoxemia

- Chest x-ray: mediastinal widening

Inhalational (Pulmonary) Anthrax

- Diagnosis
  - Index of suspicion: exposure risk
    - Occupation
    - Location
  - Pathognomonic
    - Previously healthy adult
    - Overwhelming flu-like signs
    - Widened mediastinum

Anthrax
Anthrax

- **Diagnosis**
  - Sputum exams are **NOT** useful
  - Standard blood culture: growth in 6 - 24 H
- **Pathology:** hemorrhagic, necrotizing pneumonic lesion

- **Management**
  - Antibiotics: susceptible to
    - Ciprofloxin
    - Doxycycline
    - Penicillin
    - Amoxicillin
    - Chloramphenicol
    - Rifampin
  - **NOT** susceptible to cephalosporins

- **Supplemental oxygen**
- **Mechanical ventilation**
- **Vasopressors for shock**
- **Other supportive measures**

- **Prevention**
  - Direct, person-to-person spread is unlikely
  - Universal precautions for patient care: no special barriers
  - Antibiotics for suspected exposure (60 D)

- **Prevention: vaccination**
  - Human live attenuated vaccine
    - Three injections, two weeks apart
    - Three injections at 6, 12, 18 mo.

- **Adverse reactions**
  - Soreness, edema at injection site
  - Fever, nausea, headaches (5 - 35%)
  - Serious events 1:50,000 doses
Anthrax

- Decontamination
  - Bleach
  - Sandia foam: new, safe
  - Formaldehyde
  - Nanoemulsion

- Why anthrax?
  - It is tough
    - Sunshine kills spores
    - Heat does not kill
    - Explosion does not kill → can be dispersed by explosive shells

Smallpox

History

10,000 BC: Believed to have appeared in Africa
1350 BC: First recorded epidemic in Egypt
180 AD: Major epidemic coincides with fall of Roman empire
1500-1800 AD: Introduction of smallpox to New World decimates native population

1763: Biological warfare by placing smallpox scabs in blankets given to Native Americans
1600: Chinese introduced variolation, an early vaccination
1796: Jenner uses cowpox extract to vaccinate against smallpox

History

1967: World Health Organization campaign to eradicate smallpox
1972: Routine vaccination ceased
1980: WHO recommends cessation of vaccination
1980: Soviet government initiates program to produce large quantities of smallpox
WHO Poster: 1980

Etiology
- Causative organism: variola virus
  - DNA virus
  - Very infectious
  - Related to
    - Cowpox
    - Monkeypox
    - Vaccinia virus
  - Variola major: more virulent form
  - Variola minor: less virulent

Pathogenesis
- Transmission mode: person-to-person via droplet nuclei
- Virus implants on oropharyngeal or respiratory mucosa
- Only few varions are required to produce disease
- Viruses migrate & multiply in regional lymph nodes, spleen, & bone marrow
- Incubation: about 12 D

Manifestations: Variola Major
- Smallpox rash

Manifestations: Variola Major
- Fever
  - Malaise
  - Headache, backache
  - Maculopapular rash
    - Oropharyngeal mucosa
    - Face
    - Forearms
    - Trunk
    - Legs
### Manifestations: Variola Major

- Rash becomes pustular
- Large amount of virus in saliva: most infectious phase
- Scabs develop
- Toxemia
- Encephalitis
- Mortality (30%): 5th or 6th day after onset of rash

### Variola: Alternate Forms

#### Malignant
- Abrupt onset
- Frequently fatal

#### Hemorrhagic
- Rash hemorrhages
- Frequently fatal

### Variola: Alternate Forms

#### Variola minor
- Fewer constitutional symptoms
- Sparser rash
- Partially immune victims: similar to variola minor

### Diagnosis

#### One suspected case → international health emergency

- Characteristic rash
  - Centrifugal distribution
  - Same stage of development at each location
  - Palmar & plantar location
  - Confirmed by laboratory analysis

### Diagnosis

#### Management
- Strict isolation
- Supportive care
- Antibiotics for secondary bacterial infection
- Antiviral agents
  - Currently, none are approved
  - Agents for HIV have potential

### Prevention

#### Post-exposure control
- All face-to-face contacts with victim
  - Vaccinated
  - Surveillance for fever, rash
- Home care recommended for victims
- Vaccination of healthcare workers, police, transit workers, etc.
Hospital Infection Control

- Smallpox spreads easily by droplets
- Rooms: negative pressure with HEPA
- Vaccination of employees, patients
- Laundry & waste- biohazards

Botulism

History

- First identified as poison from sausage (botulus = sausage)
- 1735: First case described
- 1897: Botulism toxin identified
- 1930s: Japanese used as weapon
- 1991: Iraq admits to producing 19,000 L of botulism toxin

Etiology

- Causative organism: Clostridium botulinum bacterium
  - Widespread, soilborne
  - Obligate anaerobe
  - Spore-forming
  - Produces botulinum neurotoxin
    - Colorless
    - Odorless, tasteless
    - Inactivated by heat

Forms

- Food-borne: ingestion of toxin in foods that have not been canned or preserved properly

Forms

- Wound botulism, systemic spread of toxin produced by organisms inhabiting wounds, associated with
  - Trauma
  - Surgery
  - Subcutaneous heroin injection
  - Sinusitis from intranasal cocaine abuse
Forms

- Infant botulism
  - Intestinal colonization of organisms in infants younger than 1 year
  - Associated with ingestion of honey by infants

Modes of Toxin Transmission

- Food: almost all types
  - Aerosol: bioterrorism
  - Water supply: unlikely because water treatment deactivates toxin

Manifestations

- Incubation: 2 H to 8 D after exposure, ingestion
  - Diplopia
  - Blurred vision
  - Dysphonia
  - Dysphagia
  - Dysarthria
  - Loss of gag reflex

- Paralysis
  - Loss of head control
  - Generalized weakness
  - Diaphragm & accessory ventilatory muscles
  - Recovery in weeks to months

Diagnosis

- Differential diagnosis - rule out
  - Guillain-Barre syndrome
  - Myasthenia gravis
  - Poliomyelitis

- Laboratory tests: available only at CDC
  - Blood
  - Gastric aspirates
  - Stool

Pathognomonic

- Symmetric, descending paralysis
- Afebrile patient
- Normal sensorium
Management

- Botulism is **NOT** an infection
- Evaluate airway & breathing
  - Loss of gag reflex → intubation
  - Loss of ventilatory muscles → ventilation

Management

- Botulism antitoxin: **STAT**
  - Minimizes severity
  - Does not reverse existing paralysis

Prevention

- Botulism toxoid: immunization
- Botulism antitoxin
  - Post-exposure prevention
  - Scarce

Prevention

- Decontamination: usual procedures
- Infection control
  - No isolation necessary
  - Universal precautions

Plague

- Naturally occurring plague: ancient
- 425 BC: first recorded epidemic in Athens
- 540 AD: first recorded pandemic
- 1340 AD: pandemic from China to Europe, killing 1/3 of Europeans
- 1400s AD: used as biological weapon by Tatars
- 1665 AD: great plague of London
History

- 1894: causative organism identified by Yersin, *yersinia pestis*
- Present day
  - Natural epidemics recur
  - Organism present in rodents, worldwide, including Western U.S.
- WWII: used by Japan as biological weapon
- Soviet Union developed large quantities of weapon-grade plague

Etiology

- Causative organism: *yersinia pestis*
- Insect vector: *x. cheopis* flea
- Animal reservoir: rodents
  - Rats
  - Mice
  - Prairie dogs
  - Ground squirrels

Forms

- Bubonic: buboes are infected lymph glands
- Pneumonic: pulmonary infection
- Septicemic: disseminated to blood

Transmission Modes

- Bites of infected fleas: bubonic form
- Aerosol
  - Pneumonic
  - Biological weapon

Manifestations: Bubonic

- Incubation: bubonic 2-10 D
  - Malaise
  - High fever
  - Lymph glands
    - Swollen & tender
    - May progress to buboes
  - Leukocytosis
  - Mortality 50%, if untreated

- Gram-negative bacillus

- Natural epidemics recur
- Organism present in rodents, worldwide, including Western U.S.
- WWII: used by Japan as biological weapon
- Soviet Union developed large quantities of weapon-grade plague
Manifestations: Bubonic
- Incubation 2-3 D
- Malaise
- High fever, chills
- Headache
- Hemoptysis
- Leukocytemia

Manifestations: Pneumonic
- Rapidly progressive bronchopneumonia
- Dyspnea
- Stridor
- Hypoxemia
- Mortality: 100% if untreated

Diagnosis
- Index of suspicion: sudden outbreak of severe pneumonia & sepsis
- Gram stain: sputum or blood, gram negative bipolar rod

Management
- Antibiotics: initiate STAT
  - Streptomycin: drug of choice
  - Gentamicin
  - Doxycycline
  - Tetracycline
  - Chloramphenicol
  - Trimethoprim-sulfamethoxazole
  - NOT cephalosporins

Management
- Supportive measures
  - Oxygen
  - Mechanical ventilation
Prevention

- Post-exposure antibiotics: seven days post-exposure
  - Tetracycline
  - Doxycycline
  - TMP-SMT
  - Chloramphenicol

Prevention

- Isolation
  - Respiratory isolation of patient for first 48 hours
  - Close contacts who refuse chemoprophylaxis
- Vaccine: limited availability
- Decontamination: usual measures

Additional Bioterrorist Threats

- Tularemia: extremely infectious bacterium
- Ebola: rapidly fatal virus
- Aflatoxin: carcinogen
- Clostridium perfringens: gangrene
- Ricin: slow poison

Summary & Review

- Anthrax
  - Antracis bacillus
  - Cutaneous, gastrointestinal, pulmonary
  - Pulmonary manifestations
  - Management
  - Prevention: immunization, chemoprophylaxis
  - Universal precautions

Summary & Review

- Smallpox
  - Variola major
  - Communication: droplet nuclei
  - Primary manifestation: centrifugally distributed rash
  - Management
    - Supportive
    - Isolation
    - Home care

Summary & Review

- Smallpox
  - Prevention: vaccination
  - Precautions
    - Strict isolation
    - Biohazardous waste
Summary & Review

Botulism

- *Clostridium botulinum:* produces neurotoxin
- **Sources**
- **Manifestation:** descending paralysis
- **Management**
  - May require intubation, ventilation
  - Antitoxin
- **Prevention:** immunization (botulinum toxoid)
- **Universal precautions**

Plague

- *Yersinia pestis:* gram negative rod
- **Insect vector (flea)**
- **Infected rodents**
- **Types:** bubonic, pneumonic, septicemic
- **Manifestations:** buboes, pneumonia
- **Management:** antibiotics, etc.
- **Prevention:** immunization, chemoprophylaxis
- **Precautions:** isolation first 48 hours

References

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