Bioterrorist threats: sources, recognition and safety issues

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Learning Objective

- Describe the etiology and pathology of likely bioterrorist threats.
- Describe the clinical manifestations of conditions caused by bioterrorism.
- Explain the management strategies for conditions caused by bioterrorism.
- Explain the 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- US develops weapons

History

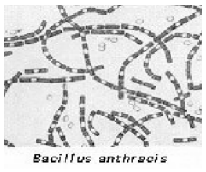
- 1969- US ends weapons program
- 1970- anthrax vaccine FDA approved
- 1972- International convention outlaws biological weapons
- 1995- Iraq admits to producing 8500 L of anthrax weapon
- 2001- letter containing anthrax is mailed to NBC

Etiology

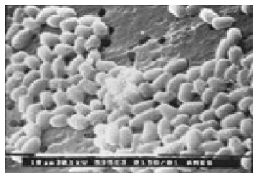
- Causative organism- bacillus anthracis
  - gram-positive, spore-forming rod
  - spore-forming ==> very tough organism
  - occurs globally, esp. in developing countries
  - primarily infects herbivores
  - produces lethal toxin

Etiology

- Bacillus anthracis



vegetative organism



spores on SEM

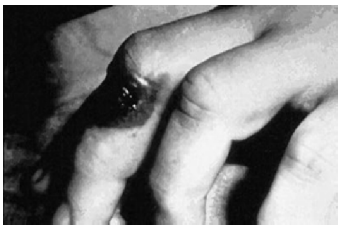
Routes For Transmission

- cutaneous- most common
- gastrointestinal- 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

Cutaneous Anthrax



Cutaneous Anthrax

- Manifestations
  - Proximal lymphedema develops
  - Infection disseminates
    - septicemia
    - meningitis
  - Frequently fatal, if untreated

Gastrointestinal Anthrax

- Manifestations- inflammation of GI tract
  - nausea
  - hematemesis
  - fever
  - acute abdomen- abdominal pain
  - severe diarrhea
  - sepsis
- High mortality rate

Inhalational (Pulmonary) Anthrax

- Etiology- inhalation of spores
  - special processing for deposition
  - 1-5 micron
  - too large- upper airway deposition
  - too small- exhaled

Inhalational (Pulmonary) Anthrax

- Incubation period- generally 3-5 D, depends on germination rate
- Manifestations- early
  - fever, chills
  - dyspnea
  - cough
  - headache
  - nausea & vomiting
  - chest pain

Inhalational (Pulmonary) Anthrax

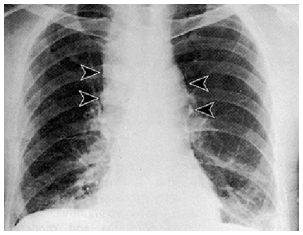
- Manifestations- fulmination
  - fever
  - dyspnea
  - stridor- mediastinal enlargement
  - diaphoresis

Inhalational (Pulmonary) Anthrax

- Manifestations- fulmination
  - fever
  - dyspnea
  - stridor- mediastinal enlargement
  - diaphoresis
  - shock
  - hemorrhagic meningitis- delirium
  - hypoxemia

Inhalational (Pulmonary) Anthrax

- chest xray- mediastinal widening



Anthrax

- Diagnosis
  - index of suspicion- exposure risk
    - ►occupation
    - ►location
  - pathognomonic
    - ►previously healthy adult
    - ►overwhelming flu-like signs
    - ►widened mediastinum

Anthrax

- Diagnosis
  - sputum exams are NOT useful
  - standard blood culture- growth in 6-24 H
- Pathology- hemorrhagic, necrotizing pneumonic lesion

Anthrax

- Management
  - Antibiotics- susceptible to:
    - ciproflaxin
    - doxycycline
    - penicillin
    - amoxacillin
    - chloramphenicol
    - rifampin
  - NOT susceptible to cephalosporins

Anthrax

- Management
  - supplemental oxygen
  - mechanical ventilation
  - vasopressors for shock
  - other supportive measures

Anthrax

- Prevention
  - direct, person-to-person spread is unlikely
  - universal precautions for patient care- no special barriers
  - antibiotics for suspected exposure (60 D)

Anthrax

- Prevention- vaccination
  - human live attenuated vaccine
    - three injections, two weeks apart
    - three injections at 6, 12, 18 mo.

Anthrax

- Prevention- vaccination
  - 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

Anthrax

- 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

History

- 1763- biological warfare by placing smallpox scabs in blankets given to Native Americans by British soldiers
- 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 and multiply in regional lymph nodes, spleen & bone marrow
- Incubation- about 12 D

Manifestations- Variola Major

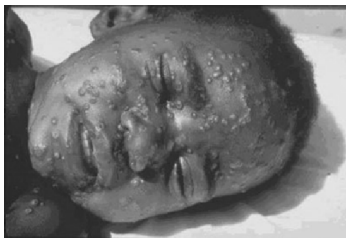
- Fever
- Malaise
- Headache, backache
- Maculopapular rash
  - oropharyngeal mucosa
  - face
  - forearms
  - trunk
  - legs

Manifestations- Variola Major

- Smallpox rash

Manifestations- Variola Major

- Smallpox rash



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 and plantar location
  - confirmed by laboratory analysis

Management

- strict isolation
- supportive care
- antibiotics for secondary bacterial infection
- antiviral agents
  - ►vaccination with newer vaccines can prevent or lessen the severity if given within 2 to 3 days of the initial exposure.
  - ►tecoviromat- FDA approved in 2018
  - ►cidofovir- not yet FDA approved, but
  - ►brincidofovir - not yet FDA approved, but

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 and waste- biohazards

DEADLY NIGHTSHADE

Deadly nightshade

- Extremely poisonous plant

Deadly nightshade

- Spread by suicide bomber
- Nightshade induces terminal flatulence (TF), which disperses poison
- Early warning signs:
  - peeling wallpaper
  - wilting shrubbery
  - death of small pets
- Casualty prevention - vacuum hose to bomber to remove and filter the gas

Deadly nightshade

- Save our planet
- Join the TF Assocation today

Tularemia

Tularemia

- Causative agent
  - francisella tularensis
  - gram negative bacterium
  - zoonotic organism (rabbit fever)
- Communication route(s)
  - contact with infected animals
  - vectors; e.g., ticks, flies
  - inhalation (bioterrorism)
  - no person-to-person transfer

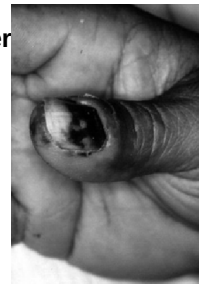
Tularemia

- Disease carriers



Tularemia

- Manifestations (ulceroglandular form)
  - cutaneous ulcer



Tularemia

- Manifestations (ulceroglandular form)
  - cutaneous ulcer
  - lymph gland enlargement
  - fever, chills
  - headache, malaise
  - may progress to pneumonia

Tularemia

- Manifestations (bioterrorist forms)
  - incubation - 2-10 days
  - typhoidal form
    - fever,
    - cough,
    - chest pain
    - shortness of breath
    - mortality - 35%

Tularemia

- Manifestations (bioterrorist forms)
  - pneumonic form - severe atypical pneumonia
    - ARDS ==> respiratory failure
    - mortality unknown - no opportunity for study

Tularemia

- Diagnosis
  - may be missed on sputum exam
  - histology - intracellular organisms
  - serology
- Management
  - support - ventilation, oxygen
  - antibiotics
    - streptomycin - drug of choice
    - gentamycin, amikacin
    - chloramphenicol (meningitis)

Tularemia

- Prevention
  - antibiotics for suspected exposure
  - universal precautions for victims

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

Manifestations

- Paralysis
  - loss of head control
  - generalized weakness
  - diaphragm & accessory ventilatory muscles
  - recovery in weeks to months

Manifestations

- Pathognomonic - similar to mysathenia gravis
  - symmetric, descending paralysis
  - afebrile patient
  - normal sensorium

Diagnosis

- Differential diagnosis- rule out:
  - Guillain-Barre syndrome
  - Myasthenia gravis
  - Poliomyelitis
- Laboratory tests- available only at CDC
  - blood
  - gastric aspirates
  - stool

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

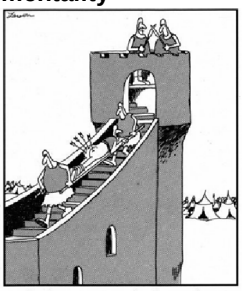
PLAGUE

History

- 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 to win seige war
- 1665 AD- great plague of London

History

- Seige mentality



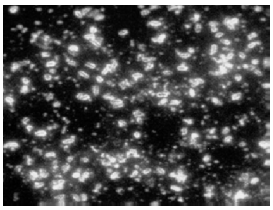
"So then I says to Borg, 'You know, as long as we're under seige, one of us oughta moon these Saxon dogs.'"

History

- 1894- causative organism identified by Yersin, 'yersinia pestis'
- present day
  - natural epidemics recur
  - organism present in rodents, worldwide, including Western US
- WWII- used by Japan as biological weapon
- Soviet Union developed large quantities of weapon-grade plague

Etiology

- causative organism
  - yersinia pestis
  - gram-negative bacillus



Etiology

- 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

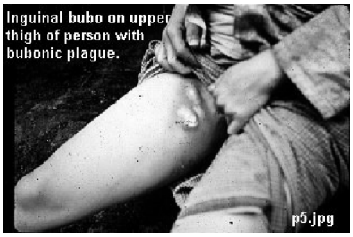
Transmission Modes

- 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

Manifestations- Bubonic



Manifestations- Pneumonic

- 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
  - gentamycin
  - 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

- Ebola- rapidly fatal virus
- Aflatoxin- carcinogen
- Clostridium perfringens- gangrene
- Ricin- slow poison

Summary and Review

- Anthrax
  - antracis bacillus
  - cutaneous, gastrointestinal, pulmonary types
  - pulmonary manifestations:
  - management
  - prevention- immunization, chemoprophylaxis
  - universal precautions

Summary and Review

- Smallpox
  - variola major
  - communication- droplet nuclei
  - primary manifestation- centrifugally distributed rash
  - management
    - supportive
    - isolation
    - home care

Summary and Review

- Smallpox
  - prevention- vaccination
  - precautions
    - strict isolation
    - biohazardous waste

Summary and Review

- Botulism
  - clostridium botulinum- produces neurotoxin
  - sources
  - manifestation- descending paralysis
  - management
    - may require intubation, ventilation
    - antitoxin
  - prevention- immunization (botulinum toxoid)
  - universal precautions

Summary and Review

- 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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