ANTHRAX, SMALLPOX, BOTULISM AND PLAGUE

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Learning Objectives

- Describe the history of anthrax.
- Describe the anthrax bacillus.
- Describe the etiology, manifestations, management and prevention of anthrax infections.
- Discuss anthrax vaccination

Learning Objectives

- Outline the history of smallpox.
- Describe the etiology, manifestations, management and prevention of smallpox infections.
- Discuss smallpox vaccination.

Learning Objectives

- Outline the history of botulism.
- Describe the clostridium bacillus.
- Describe the etiology, manifestations, prevention and management of botulism poisoning.

Learning Objectives

- Outline the history of plague
- Describe the pasturella yersinia bacillus.
- Describe the etiology, manifestations, management and prevention of plague.
- Discuss plague vaccination

ANTHRAX

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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

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

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

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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
  - chest xray- mediastinal widening
  - hypoxemia

Anthrax

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

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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

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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
- 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

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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

- 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

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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

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 and 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

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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.

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

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Manifestations

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

Manifestations

- Pathognomonic
  - 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

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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
- 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 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

- causative organism- yersinia pestis
- insect vector- x. cheopis flea
- animal reservoir- rodents
  - rats
  - mice
  - prairie dogs
  - ground squirrels

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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- 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

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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

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

Review & Summary

- Anthrax
  - history- plague of boils to recent postal situation
  - forms- cutaneous, pulmonary, GI
  - anthrax bacillus- spore-former
  - signs
    - cutaneous- spider bite
    - pulmonary- flu & pneumonia

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Review & Summary

- Anthrax
  - pathognomonic
    - previously healthy adult
    - overwhelming flu-like signs
    - widened mediastinum
  - management
    - antibiotics- doxycycline, ciproflaxin
    - ventilation
  - prevention- prophylactic antibiotic, vaccine

Review & Summary

- Smallpox
  - history
    - ancient, first used as weapon in 1700s
    - disease conquered- vaccination discontinued
    - virus still manufactured
  - cause- potent virus that kills 30%
  - transmission- aerosol

Review & Summary

- Smallpox
  - manifestation
    - centrifugal rash
    - prostration
    - toxemia
    - encephalitis
  - management
    - strict isolation
    - antibiotics for secondary infection

Review & Summary

- botulism
  - history
    - identified as poison in sausage
    - used as weapon by Japanese
    - mass-produced by Iraq
  - causative organism- clostridia botulinum produces toxin
  - transmission- food, aerosol

Review & Summary

- botulism
  - manifestations- pathognomonic
    - symmetric, descending paralysis
    - afebrile patient
    - normal sensorium
  - management
    - monitor for intubation & ventilation
    - antitoxin

Review & Summary

- plague
  - history
    - ancient- epidemics from 400 BC
    - used by Japan as weapon
    - produced by Soviet Union
  - etiology
    - organism- yersinia pestis, a gram negative rod
    - vector- x. cheopis, a flea
    - animal reservoir- rodents

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Review & Summary

- plague
  - forms- bubonic, pneumonic, septic
  - manifestations
    - buboes
    - overwhelming bronchopneumonia
  - management
    - antibiotics- aminoglycosides, tetracyclines, sulfonamides

Review & Summary

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

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