Identification, treatment and decontamination procedures regarding Yersinia pestis following a Biowatch Actionable Result (BAR)

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Plague - An Introduction
Lesson 1

Overview
Objectives

- Identify plague bacterium
- Epidemiology
- Natural Occurrence
Bio-Terror Threat

• Plague can cause large numbers of cases of severe or fatal cases
• Could create panic
• Considered for use since 14th century
Clinical Syndromes

- Bubonic
- Pneumonic
- Septicemic
- Plague Meningitis
- Pharyngeal

“Safety Pin” Y. Pestis in blood
Bubonic Plague

- Infected flea bite
- Exposure through break in skin
- No person-to-person
- Untreated progresses to pneumonic
Bubonic Plague

- Bite of a plague-infected flea
- Bacteria migrate through cutaneous lymphatics to regional lymph nodes where they are phagocytosed but resist destruction.
- Rapidly multiply causing destruction and necrosis of lymph node.
- Bacteremia, septicemia, and endotoxemia can lead quickly to shock, disseminated intravascular coagulation, and coma.
Pneumonic Plague

- Inhalation of plague bacteria
- Disease progression
  - Respiratory failure
  - Shock
  - Rapid death
- Person-to-person transmission
Pneumonic Plague

- A small number of patients with bubonic plague or septicemic plague develop secondary pneumonic plague and can then spread the disease by respiratory droplet. Persons infected by this route develop primary pneumonic plague.
Pneumonic Plague

- Outbreak symptoms would resemble other severe respiratory illnesses.
- Size of the outbreak would depend on:
  - Quantity of the agent
  - Characteristics of the strain
  - Environmental conditions
  - Methods of aerosolization
Feline Pneumonic Plague

- Two cases of primary pneumonic plague were contracted by humans after handling cats with pneumonic plague.
- Both patients had pneumonic symptoms as well as prominent gastrointestinal.
- Diagnosis and treatment were delayed more than 24 hours after symptoms onset.
- Both patients died.
Pneumonic Plague

- In the US from 1950 to 2000 four of the seven reported primary pneumonic plague patients died.
Septicemic Plague

- **Primary Form**
  - Direct inoculation in bloodstream

- **Secondary Form**
  - Development of untreated pneumonic or bubonic plague
Epidemiology
Natural Reservoirs

• Bites of infected flea
• Most common – *Oropsylla montana*
• Blood meal from bacteremic animal
• Regurgitates into human/animal host
• Common reservoirs
  ▫ Deer mice
  ▫ Ground squirrels
Epidemiology Transmission

- Bite of infected flea
- Respiratory droplets
- Direct contact (6 feet)
- Direct skin/mucous membrane less common
- BT event – Respiratory droplets or aerosols
Plague Incidence
United States, 1970-2003

- Endemic to US
- Bubonic Most Common
  - 83% Bubonic
  - 2% Primary Pneumonic
  - 15% Septicemic
- 5 to 15 cases per year
- Greatest Concentrations
  - Arizona, Colorado, New Mexico, Utah
Plague Case Fatality Rates
United States, 1970 - 1977

- In US, 14% died
- Untreated – 50 to 90%
- Treated – 15%
- Deaths mostly from delays in diagnosis and treatment

- All inhabited continents, but Australia
- 1,500 to 3,000 cases annually
- Greatest Concentrations
  - Asia, South America
Plague as a Weapon

- *Y. pestis* is available almost world-wide.
- Capacity for mass production
- Difficult to prevent such activity
- High fatality rate of pneumonic plague
- Potential for secondary spread
World War II

- Secret branch of Japanese army, Unit 731, is reported to have dropped plague-infected fleas over populated areas of China, thereby causing outbreaks of plague.
Biological Weapons Programs

- United States and Soviet Union developed techniques to aerosolize plague directly, eliminating dependence on the unpredictable flea vector.
- US offensive program terminated in 1970.
- Soviet scientists manufactured large quantities of the agent suitable for weapons.
In a worst case scenario, if 50 kg of *Y. pestis* were released as an aerosol over a city of 5 million, pneumonic plague could occur in as many as 155,000 persons, 36,000 of whom would be expected to die.

The plague bacilli would remain viable as an aerosol for 1 hour for a distance up to 10 km. Significant numbers of city inhabitants might attempt to flee, further spreading the disease.
Bioterrorism

• 1995 Ohio microbiologist with suspect motives was arrested after fraudulently acquiring *Y. pestis* by mail.
Plague Bioterrorism

- Most dangerous as aerosol
- Outbreak of pneumonic
- Possibly pharyngeal or ocular
- Report all suspect cases to public health immediately
The route of transmission of primary ocular plague is not known. Wildlife species may serve as sentinels.

Ocular Plague in Mule Deer from Wyoming and Oregon
No evidence that the residual plague bacilli pose an environmental threat to the population following the dissolution of the primary aerosol.

No spore form of *Y. pestis*.

Sensitive to sunlight and heating.

Plague aerosol is estimated to be effective and infectious for as long as 1 hour.
Clinical Presentation
Objectives

- Identify distinctions between:
  - Bubonic Plague
  - Pneumonic Plague
  - Septicemic Plague
Bubonic Plague

- Incubation: 2 to 6 days
- Symptoms
  - Lymphadenopathy, fever
  - Buboes at site of inoculation
- Disease Progression - Untreated
  - Septicemia
  - Secondary Pneumonic Plague
  - Meningitis (rare)
Bubonic Plague
Bubonic Plague
Bubonic Plague
Pneumonic Plague

- Incubation: 2 to 4 days (range 1 to 6 days)
- Symptoms
  - Acute fever, chills, malaise, myalgias
  - Productive cough
  - Watery mucoid sputum, may be bloody
  - Associated chest pain, increasing dyspnea
Pneumonic Plague

• Disease Progression
  ▫ Adult Respiratory Distress Syndrome
  ▫ Refractory pulmonary edema
  ▫ Signs of shock
  ▫ Without treatment in less than 24 hours, almost universally fatal
Pneumonic Plague

- Coughing patient can spread
- Respiratory precautions
- Rapidly expanding bronchopneumonic infiltrates
- Pulmonary parenchymal necrosis and hemorrhage
- Occasional pulmonary abscesses
- Enlarged hilar nodes and pleural effusions
Pneumonic Plague
Pneumonic Plague
Pneumonic Plague
Septicemic Plague

- Incubation: Most common as complication of pneumonic or bubonic plague
- Symptoms
  - Acute fever, chills, prostration, abdominal pain, nausea, vomiting
- Disease Progression
  - Hypotension and other signs of shock
  - Disseminated Intravascular Coagulation
  - Purpura
  - Fatal if not treated
Other Plague Presentations

- **Pharyngeal Plague**
  - Uncommon
  - Resembles tonsillitis with peritonsillar abscess
  - Cervical lymphadenopathy

- **Plague Meningitis**
  - Most common in children
  - Usually end result of ineffective treatment of other forms
  - Symptoms mimic other forms of acute plague
Infection Control

- Large numbers of plague bacilli
- Respiratory droplet spread in close direct contact
- Respiratory droplet precautions with suspect cases
- Contact public health
First Receiver Decontamination Operations
Why Decontaminate?

- To remove known or suspected hazardous substance from victim
- To decrease the amount of contact the victim has with the hazardous substance
- To prevent contamination of staff, other patients or visitors
- To prevent contamination of the facility
Types of Decontamination - Gross Decontamination

- This type of decontamination:
  - Is performed at the incident site or decon area
  - Significantly reduces surface contaminant
  - Must be performed as quickly as possible
  - Uses low-pressure, high-volume water
Types of Decontamination - Secondary Decontamination

- This type of decontamination:
  - Used after gross decontamination
  - More thorough, focusing on removing all remaining contaminant
First Receivers: Who are they?

- First receivers typically include personnel in the following roles:
  - Clinicians and other staff who have a role in receiving and treating contaminated victims (e.g., triage, decontamination, medical treatment, and security)
  - Those whose roles support these functions (e.g., set up and patient tracking).
Exposure Versus Contamination

Exposed

VS

Contaminated
Exposure

- The victim has had **no direct contact with hazardous substance(s)**.
  - The victim has been exposed to vapor, smoke, gas.
  - Victim exhibits respiratory symptoms, watery eyes or GI symptoms.
  - Should be **triaged to be decontaminated last** and decontamination should be short due to the lack of contaminant present on the patient’s skin/clothing.
Contamination

- **The victim has had **direct contact** with the hazardous substance(s).**
  - Deposition of the substance on the person of the victim or absorption of a hazardous substance(s) has occurred.
  - Presenting signs/symptoms dependent on chemical and length of contact.
  - Should be **triaged to be decontaminated first** and will need to be deluged for longer periods of time based on the amount of contaminant present. Treatment may need to begin while patient is being decontaminated.
Types of Contaminates

Water
Definition of Copious

Copious

adj.

1. abundant; extensive in quantity
2. having or providing an abundant supply
3. full of words, ideas, etc.; profuse
The Solution is Dilution

- The more water, the better (hi-volume, low pressure); copious amounts of water is needed
- Works on every agent and industrial chemical
- Don’t trade human life and safety for the environment
- Makes the decontamination process consistent
This is **NOT**

Copious Amounts of Water
This is Copious Amounts of Water

Definition of deluge:
A large amount of rain that suddenly falls in an area

- A deluge kit yields approximately 60 gallons per minute.
Personal Protective Equipment

Street Clothes

Level D

Level C

Level B

Level A
Personal Protective Equipment

- **Level C** - The concentration(s) and type(s) of airborne substance(s) is known and the criteria for using air purifying respirators are met.
  - Air-purifying respirator (APR), NIOSH-certified
  - Respiratory protection for select vapors, aerosols
  - Hooded, splash-protective chemical resistant suit
Recommendations

- Based upon **OSHA’s Best Practices for Hospital-Based First Receivers** (OSHA 3249-08N 2006) and Agency for Toxic Substances and Disease Registry (ATSDR) Managing Hazardous Materials Incidents (ATSDR, 2001):
  - PPE recommended for hospital first receivers is Level C+ (Level C with additional respiratory protection), and consists of:
    - A powered air-purifying respirator (PAPR) with chemical cartridges;
    - A chemically resistant suit;
    - Double gloves; and,
    - Chemically resistant boots.
Deluge System
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