

# PLAGUE

## ALL SUSPECT CASES OF PLAGUE MUST BE REPORTED IMMEDIATELY TO THE HEALTH AND HUMAN SERVICES COMMUNICABLE DISEASE CONTROL:

During business hours: (916) 875-5881  
After hours (Health Officer On call): (916) 875-5000

### **Epidemiology:**

- Highly infectious after aerosolization
- Person-to-person and animal-to-human transmission can occur with pneumonic plague via respiratory droplet

### **Clinical:**

- Incubation period is 1-3 days (ranges up to 7 days)
- Aerosolization would most likely result in pneumonic plague
- Pneumonic plague presents with acute onset of high fevers, chills, headache, malaise and a productive cough, that is initially watery before becoming bloody

### **Laboratory Diagnosis:**

- Bacterial cultures (blood, sputum, or lymph node aspirate specimens) should be handled in a Biosafety Level 2 facility
- Wright, Giemsa, or Wayson stain shows gram negative coccobacilli with bipolar "safety-pin" appearance
- Organism grows slowly (48 hrs for observable growth) on standard blood and MacConkey agar
- Immunofluorescent staining for capsule (F1 antigen) is diagnostic
- Fluorescent antibody tests available through The Laboratory Response Network
- Contact the Sacramento County Public Health Laboratory for assistance

### **Patient Isolation:**

- Strict respiratory isolation with droplet precautions (gown, gloves, and eye protection) until the patient has received at least 48 hours of antibiotic therapy and shows clinical improvement

### **Treatment:**

- Streptomycin (1 g IM bid) or gentamicin (5 mg/kg IM or IV qd) are the preferred antibiotics
- Tetracyclines or fluoroquinolones are alternative choices
- Co-trimoxazole is recommended for pregnant women and children between the ages of 2 months and 8 years
- Chloramphenicol should be used for plague meningitis

### **Prophylaxis:**

- Antibiotic prophylaxis is recommended for all persons exposed to the aerosol or persons in close physical contact with a confirmed case
- Tetracyclines or fluoroquinolones are recommended for 7 days from last exposure to a case



**SACRAMENTO COUNTY  
HEALTH AND HUMAN SERVICES  
COMMUNICABLE DISEASE CONTROL**

**Medical Treatment and Response to Suspected Plague:  
Information for Health Care Providers During Biologic Emergencies**

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## I. KEY SUMMARY POINTS

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## II. Introduction/Epidemiology

Plague is transmitted by a gram-negative bacillus, *Yersinia pestis*, of the family Enterobacteriaceae. Plague is a zoonosis and can be transmitted by flea vectors from rodents to humans, and by respiratory droplets from animals to humans and humans to humans. Plague has three clinical forms: bubonic, primary septicemic and pneumonic disease. **Primary pneumonic plague would be the most likely presentation in the event of a biological attack.**

Naturally-occurring plague is a disease primarily affecting rodents. Transmission between rodents is via infected fleas. Transmission to humans can occur by respiratory droplets from rodents, from other infected animals/materials to humans or from human to human. In the United States, transmission to humans has been primarily from the bites of fleas from infected rodents. Less frequently, infection is caused by direct contact with body fluids or tissues while handling an infected animal. Currently in the United States, infected cats are the only source of primary pneumonic plague for humans, since persons who develop secondary plague pneumonia usually receive appropriate isolation and treatment before secondary transmission can occur.

Human plague has been reported most often from the four western states of New Mexico, Arizona, Colorado and California. In the United States, 341 cases of human plague were reported during 1970-1995; the overwhelming majority of cases were bubonic plague.

**Since primary pneumonic plague can be transmitted from person to person, patients with compatible clinical symptoms should be placed in respiratory isolation.**

### III. **Significance as a Potential Bioterrorist Agent**

- Could be released as an aerosol during a bioterrorist attack
- Has been weaponized by both the United States, former Soviet Union and Japan. Japan purportedly released plague over China during World War II.
- Potential for secondary transmission is highest with pneumonic plague.
- Aerosolized plague would cause pneumonic disease, with high mortality rates if untreated.

### IV. **Clinical Manifestations**

**During an act of bioterrorism, release of an aerosol will be the most likely method of dispersal, so that most patients will present with primary pneumonic plague.**

#### **A. Primary Pneumonic Plague**

***Incubation period*** - typically 1-3 days (ranges up to 7 days)

***Symptoms*** - Patients exhibit acute and often fulminant onset of high fever, malaise, headache, myalgias and cough with production of sputum that is initially watery, before becoming bloody. Pneumonia rapidly progresses to dyspnea, stridor and cyanosis. Patients may develop respiratory failure, shock and ecchymoses.

#### **B. Primary Septicemic Plague**

***Incubation period*** - 1-7 days

***Symptoms*** - Clinically resembles septicemia caused by other gram negative bacteria. Patients are febrile and often have chills, headache, malaise and gastrointestinal disturbances. May progress rapidly to septic shock, consumptive coagulopathy, meningitis and coma. Patients may develop secondary plague pneumonia.

## C. Bubonic Plague

***Incubation period*** - 2-7 days

***Symptoms*** - Patients develop fever, headache, chills and swollen, extremely painful lymph nodes (buboes). Nausea, vomiting and diarrhea are common. Swollen nodes typically involve the nodes that drain the site of initial infection. Patients generally do not have overlying skin lesions. Patients may develop secondary septicemic plague or secondary plague pneumonia.

## V. Laboratory Diagnosis

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**Laboratory work must be done in Biosafety Level 2 facilities. If plague is suspected, please call the Sacramento County Public Health Laboratory at (916) 874-9231 to arrange for submission of specimens for testing and/or confirmation at the state Microbial Diseases Laboratory. After hours, please call Sacramento County Health Officer On call, at (916) 875-5000.**

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The diagnosis of plague may be suspected based on characteristic findings on microscopic staining of appropriate body fluids and confirmed by immunofluorescent staining for the capsule or bacterial culture. Serology is generally used retrospectively to confirm suspect cases.

### o **Staining of Specimens**

- Appropriate clinical specimens include: blood, bubo aspirates, sputum, CSF (if signs/symptoms of meningitis) and skin scrapings (if a lesion is present).
- **Gram stain:** polymorphonuclear leukocytes and bipolar staining, "safety-pin" ovoid, gram-negative coccobacilli identified in bubo aspirate, sputum or CSF are highly suggestive of plague.
- **Wayson stain:** *Yersinia pestis* appears as light blue bacilli with dark blue polar bodies on a contrasting pink ground.

- **Immunofluorescent staining of capsule (F1):** A positive finding is diagnostic. Must use fresh specimens to avoid false negatives. This test is available only at reference laboratories.
- **Bacterial cultures**

Blood, bubo aspirates, sputum, CSF and skin scrapings can be cultured.

Materials should be inoculated into blood and MacConkey agar plates and infusion broth. It generally takes 2 days to identify visible colonies. Rapid biochemical identification systems may not be reliable for identification due to slower growth rate of *Y. pestis*.

- **Serologic Testing**

Several serologic tests are available including a passive hemagglutination test (CDC). A fourfold or greater rise is diagnostic, a single titre of > 1:16 in someone without prior immunization against plague is suggestive. Serology is not useful for rapid diagnosis.

## VI. **Handling Laboratory Specimens**

Laboratory staff handling specimens from persons who are suspected of having plague should follow Biosafety Level 2 precautions. Staff must wear surgical gloves, protective gowns and shoe covers. Laboratory tests should be performed in Biological Safety Level 2 cabinets, and blood cultures should be maintained in a closed system. Every effort should be made to avoid splashing or creating an aerosol, and protective eye wear and masks should be worn if work cannot be done in a Biological Safety Level 2 cabinet.

Laboratories working with a large amount of organism or doing studies on antibiotic resistant strains should use Biological Safety Level 3 cabinets. A full-face mask respirator with a HEPA (high efficiency particulate air) filter is an acceptable but cumbersome alternative to masks and protective eye wear.

Accidental spills of potentially contaminated material should be decontaminated immediately by covering liberally with a disinfectant solution (0.1% sodium hypochlorite or sodium hydroxide (0.1N)). All biohazardous waste should be decontaminated by autoclaving. Contaminated equipment or instruments may be decontaminated with a hypochlorite solution, hydrogen peroxide, peracetic acid, 1% glutaraldehyde solution,

formaldehyde, ethylene oxide, copper irradiation, or other O.S.H.A. approved solutions, or by autoclaving or boiling for 10 minutes.

## VII. Treatment

**Supportive care combined with the rapid administration of parenteral antibiotics are the keys to successful management of plague. Plague pneumonia is almost always fatal if antibiotics are not begun within 24 hours of onset of symptoms.**

### o **Recommended Antibiotics**

The drug of choice for primary pneumonic plague is **streptomycin** [30 mg /kg/day administered by intramuscular injection every 12 hours (15 mg/kg) for 10 days]. However, since streptomycin may be in short supply, **Gentamicin** [1.7 mg/kg every 8 hours intravenously or intramuscularly for 10 days] and **doxycycline** [200mg intravenous loading dose, followed by 100mg IV every 12 hours for 10-14 days] are alternative agents.

**Chloramphenicol** should be used for plague meningitis due to its better CNS penetration [loading dose of 25 mg/kg intravenously followed by 50-75 mg/kg/day divided into four equal doses; continue for 10 days after clinical improvement].

**Antibiotic choice may need to be altered as susceptibility information becomes available.**

### o **Alternative Antibiotics**

**Ciprofloxacin** [400 mg intravenously every 12 hours], **Levofloxacin** [500 mg intravenously every 24 hours], and **Ofloxacin** [400 mg orally every 12 hours] are acceptable alternative agents. The efficacy of quinolones in humans has not been formally evaluated.

**Bactrim** [ 1 double-strength tablet orally every 12 hours or its intravenous equivalent] may also be efficacious based on animal and in vitro studies.

Much less effective drugs (**do not use** unless all other alternatives are unavailable) include: rifampin, aztreonam, ampicillin, ceftazadime, cefotetan and cefazolin.

### o **Supportive therapy** - Supportive care is essential, including intravenous fluids and hemodynamic monitoring.



- **Therapy in pediatric patients**

First-line agents: **streptomycin** [15 mg/kg intramuscularly every 12 hours] or **gentamicin** [1.7 mg/kg intramuscularly or intravenously every 8 hours].

*Alternatively: If > or = 8 years of* - **Doxycycline** [100 mg intravenously or orally

**age**

every

12 hours if > 45 kg; 2.2mg/kg intravenously or orally

every 12 hours if < 45 kg],

**If < 8 years of age - Co-trimoxazole** [4 mg/kg orally or

intravenously

every 12 hours].

- Newborns up to age 2 months, **ciprofloxacin** 10-20 mg/kg intravenously or orally twice daily, do not exceed 1 gram/day.
- **Therapy in pregnant women** - Avoid streptomycin in pregnancy due to its association with irreversible deafness in children exposed in utero. Gentamicin can be used (1.7 mg/kg every 8 hours). **Bactrim DS [1 tablet twice daily or its I.V. equivalent] is the preferred therapy for pregnant women, except at term, when a fluoroquinolone** (Ciprofloxacin 500 orally or intravenously every 12 hours) **is preferred**. If worsening illness, add a tetracycline agent as the benefits outweigh the risks. (NOTE: Liver function tests should be monitored due to potential hepatotoxicity with tetracycline use during pregnancy.)

## VIII. **Isolation of Patients**

Pneumonic plague can be spread from person-to-person by droplet transmission (coughing, sneezing). All staff should observe **Standard Precautions** when caring for patients with suspected or confirmed plague. Patients with **pneumonic plague** should be placed on **strict respiratory isolation with Droplet Precautions until 48 hours of appropriate antibiotics** have been administered AND the patient is showing clinical improvement. Droplet precautions require that the patient be placed in a private room and that persons entering the patient room wear a surgical mask, especially when within three feet of the patient. *Negative pressure rooms are not indicated*. Transmission can occur from plague skin lesions (such as draining buboes or abscesses) to contacts; wound and skin precautions should be followed if skin lesions are present.

Multiple patients with pneumonic plague may be cohorted as long as all patients are receiving appropriate therapy.

## IX. Disposal of Infectious Waste

Use of tracking forms, containment, storage, packaging, treatment and disposal methods should be based upon the same rules as all other regulated medical wastes.

## X. Autopsy and Handling of Corpses

**All postmortem procedures are to be performed using Universal Precautions.**

Efforts should be made to avoid aerosolization.

- All persons performing or assisting in postmortem procedures must wear mandated P.P.E. (personal protective equipment) as delineated by O.S.H.A. guidelines.
- Instruments should be autoclaved or sterilized with a 10% bleach solution or other solutions approved by O.S.H.A. Surfaces contaminated during postmortem procedures should be decontaminated with an appropriate chemical germicide such as 10% hypochlorite or 5% phenol (carbolic acid).

## XI. Management of Exposed Persons

An exposed person is defined as a person who has been exposed to aerosolized *Yersinia pestis* or has been in close physical contact with a confirmed case-patient (contact at less than 2 meters during a period when the case was symptomatic and before the case had received 48 hours of antibiotic therapy). Household contacts and healthcare worker contacts should be considered exposed and should receive prophylaxis.

***Antibiotics:* All antibiotic therapy should continue for 7 days from last exposure to the case. Decisions on antibiotic therapy should be based on susceptibility results.**

### ***Non-pregnant Adult Post-Exposure Prophylaxis***

Tetracycline 500 mg every 6 hours, orally  
Doxycycline 100 mg every 12 hours, orally  
Ciprofloxacin 500 mg every 12 hours, orally  
Ofloxacin 400 mg every 12 hours, orally  
Levofloxacin 500 mg every 24 hours, orally

### **Alternative Therapy**

Trimethoprim/sulfamethoxazole 40 mg/kg/day in 2 equal doses at 12 hour intervals, orally.

***Pediatric Post-Exposure Prophylaxis*** - Co-trimoxazole is the preferred antibiotic, or when benefits outweigh the risks, consider use of doxycycline or fluoroquinolones.

<b>If &gt; or = 8 years of age: Doxycycline:</b>	If > or = 45 kg - 100 mg orally every 12 hours If < 45 kg - 2.2 mg/kg orally every 12 hours
<b>If &lt; 8 years of age: Co-trimoxazole</b>	4 mg/kg orally every 12 hours
<b>Chloramphenicol</b>	25 mg/kg orally every 12 hours
<b>Newborns up to age 2 months:</b>	<b>Ciprofloxacin</b> 10-20 mg/kg orally twice daily, do not exceed 1 gram/day.

*Pregnant Women Post-Exposure Prophylaxis* - Co-trimoxazole [1 DS tablet orally twice daily], is the preferred antibiotic, except at term, when the risk of kernicterus is greatest -- use fluoroquinolones [ciprofloxacin 500 mg orally twice daily]

## **XII. Reporting to the Health Department**

**Plague is a reportable disease in California.** *All suspect cases* should be immediately reported by telephone:

### **I. During business hours**

Sacramento County Health and Human Services, Communicable Disease Control at (916) 875-5881

### **II. After business hours**

Health Officer On call, at (916) 875-5000

## **XIII. References**

Benenson AS, ed. *Control of Communicable Diseases Manual*. 16th ed. Washington, DC: American Public Health Association; 1995:353-358.

Fleming DO, Richardson JH, Tulis JJ, Vesley D, eds. *Laboratory Safety Principles and Practices*. 2nd ed. Washington, DC: American Society for Microbiology; 1995:324.

Centers for Disease Control. Prevention of plague. MMWR. 1996;45 (Supplement RR-14):1-15.

Friedlander, AM. Anthrax. In: Sidell FR, Takafuji ET, Franz DR, eds. *Textbook of Military Medicine*. Washington, D.C.: Office of the Surgeon General at TMM Publications; 1997:479-502

Henderson DA, Inglesby TV, Bartlett JG, et al. Plague: Civilian Medical and Public Health Management following use of a Biological Weapon. *JAMA* 1999: (Awaiting publication).

Inglesby TV, Henderson DA, Bartlett JG, et al. Plague: Medical and Public Health Management following use of a biological weapon. Consensus statement of the working group on civilian biodefense. *JAMA* 1999: (in press)

Lew D. Bacillus Anthracis (Anthrax). In: Mandell G, Bennett J, Dolin R, eds. *Principles and Practice of Infectious Diseases*. 4th ed. New York: Churchill Livingstone; 1995:2070-2076.

Perry RD, Fetherston JD. Yersinia pestis- Etiologic agent of plague. *Clin Micro Reviews*. 1997;10:35-66.

Turnbull PCB, Kramer JM. Bacillus. In: Balows A, Haulser WJ, Herrman KL, Shadomy HJ, eds. *Manual of Clinical Microbiology* 5th ed. Washington, DC: American Society for Microbiology; 1991:298-299.

US Army Medical Research Institute of Infectious Diseases. Medical Management of Biological Casualties. 3<sup>rd</sup> Edition. Fort Detrick, MD. 1998.

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