

Yersinia pestis

Disease Agent:

- *Yersinia pestis*

Disease Agent Characteristics:

- Gram-negative, facultatively anaerobic, bipolar staining, bacillus to coccobacillus, nonmotile, nonspore-forming, facultatively intracellular bacterium
- Order: Enterobacteriales; Family: Enterobacteriaceae
- Size: 0.5-0.8 × 1.0-2.0 μm
- Nucleic acid: The genome of *Yersinia pestis* is 4600-4700 kb of DNA.
- Optimal growth at 28°C

Disease Name:

- Bubonic and pneumonic plague
- Black Death

Priority Level:

- Scientific/Epidemiologic evidence regarding blood safety: Theoretical
- Public perception and/or regulatory concern regarding blood safety: Absent
- Public concern regarding disease agent: High

Background:

- Longstanding pandemic and epidemic disease
- Endemic on all continents, except Australia
- Classified among the highest priority for bioterrorism agents by the CDC (Category A)

Common Human Exposure Routes:

- Bites of fleas that have fed upon bacteremic rodents
- Pneumonic plague is passed from person to person through droplet transmission.
- Human-to-human transmission is also thought to occur through the human flea (*Pulex irritans*).
- Direct contact by handling of infected tissues and through contact with respiratory secretions of infected animals

Likelihood of Secondary Transmission:

- Person-to-person transmission is significant in the case of pneumonic disease.

At-Risk Populations:

- Anyone in areas with wild rodents with enzootic plague or exposed to domestic animals infected by wild rodents
- In bioterrorism, population exposed to viable organisms or fleas infected with viable organisms

Vector and Reservoir Involved:

- Fleas, most commonly *Xenopsylla cheopis*, the oriental rat flea, but other fleas can be competent vectors.
- Reservoir is various species of mammal depending on the locale.

Blood Phase:

- High-grade bacteremia is associated with severe signs and symptoms.

Survival/Persistence in Blood Products:

- No direct evidence but is capable of growth in some media at 4°C

Transmission by Blood Transfusion:

- Theoretical; however, no reported cases and the virulence of the organism makes asymptomatic bacteremia and transfusion transmission unlikely.

Cases/Frequency in Population:

- Rare in the US, with a mean of 10-15 cases per year
- Worldwide, 1000-3000 cases, with periodic outbreaks and epidemics

Incubation Period:

- 1-7 days (1-4 days for primary pneumonic plague)

Likelihood of Clinical Disease:

- Highly infectious, with small inoculum size, essentially always associated with clinical disease

Primary Disease Symptoms:

- Bubonic plague—buboes (suppurative lymphadenitis), fever, prostration, sepsis, multiorgan involvement, and death
- Pneumonic—fever, chills, headache, myalgia, fatigue, dyspnea, chest pain, bloody sputum, respiratory failure, and shock
- Septicemic—sepsis and septic shock, without buboes

Severity of Clinical Disease:

- Considered to be the most severe acute bacterial infection in humans

Mortality:

- Bubonic plague—About 15% mortality rate for sporadic cases in endemic areas and about 60% mortality rate if untreated
- Pneumonic and septicemic plague: 100% mortality rate if untreated

Chronic Carriage:

- No

Treatment Available/Efficacious:

- Effective therapy with streptomycin, gentamicin, and chloramphenicol
- Tetracyclines, fluorquinolones, and some cephalosporins may also be active.
- Treatment must begin within 24-36 hours of onset to prevent mortality.

Agent-Specific Screening Question(s):

- No specific question is in use.
- Not indicated because of the low incidence of infection and low probability of asymptomatic bacteremia
- No sensitive or specific question is feasible.
- Under circumstances of a bioterrorism threat, the need for, and potential effectiveness of specific donor screening questions would need to be addressed.

Laboratory Test(s) Available:

- No FDA-licensed blood donor screening test exists.
- Serology: Detection of antibody to F1 capsular antigen by a passive hemagglutination (PHA) and EIA in paired or single serum samples
- Direct detection: *Y. pestis* will grow on most routine bacteriologic media. PCR and DNA hybridization techniques for identifying *Y. pestis* and other agents associated with bioterrorism have been developed.

Currently Recommended Donor Deferral Period:

- No FDA Guidance or AABB Standard exists.
- Prudent practice would be to defer donor until signs and symptoms are gone and a course of treatment is completed.

Impact on Blood Availability:

- Agent-specific screening question(s): Not applicable; in response to a bioterrorism threat, impact of a local deferral would be significant.
- Laboratory test(s) available: Not applicable

Impact on Blood Safety:

- Agent-specific screening question(s): Not applicable; unknown impact in response to a bioterrorism threat
- Laboratory test(s) available: Not applicable

Leukoreduction Efficacy:

- Unknown

Pathogen Reduction Efficacy for Plasma Derivatives:

- Specific data indicate that the multiple steps in the fractionation process are robust and capable of inactivating and/or removing bacteria at concentrations that may be present in plasma.

Other Prevention Measures:

- Licensed vaccine available for those at high risk of exposure

Other Comments:

- In a simulated bioterrorism exercise, FDA recommended that blood collection cease in the affected area and that donors in other areas be questioned about travel to the affected area.

Suggested Reading:

1. Allain JP, Bianco C, Blajchman MA, Brecher ME, Busch M, Leiby D, Lin L, Stramer S. Protecting the blood supply from emerging pathogens: the role of pathogen inactivation. *Transfus Med Rev* 2005;19:110-26.
2. Butler T. *Yersinia* infections: centennial of the discovery of the plague bacillus. *Clin Infect Dis* 1994;19:655-61.
3. Inglesby TV, Dennis DT, Henderson DA, Bartlett JG, Ascher MS, Eitzen E, Fine AD, Friedlander AM, Hauer J, Koerner JF, Layton M, McDade J, Osterholm MT, O'Toole T, Parker G, Perl TM, Russell PK, Schoch-Spana M, Tonat K; Working Group on Civilian Biodefense. Plague as a biological weapon: medical and public health assessment. *JAMA* 2000;283:2281-90.
4. Perry RD, Fetherston JD. *Yersinia pestis*—etiologic agent of plague. *Clin Microbiol Rev* 1997;10:35-66.
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