Bacillus anthracis

Disease Agent:

- *Bacillus anthracis*

Disease Agent Characteristics:

- Gram-positive, rod-shaped, aerobic, nonmotile, spore-forming, facultatively intracellular bacterium
- Order: Bacillales; Family: Bacillaceae
- Size: 3.5 μm × 1-1.2 μm
- Nucleic acid: Approximately 5200 kb of DNA

Disease Name:

- Anthrax

Priority Level:

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

Background:

- In 1876, *Bacillus anthracis* was the first microorganism identified as the cause of a specific disease by Robert Koch. During the same year, he was growing *B. anthracis* in his laboratory and within the decade, Louis Pasteur developed a viable vaccine for use in livestock. Effective animal and human vaccines were developed in the 1930s and 1960s, respectively.
- In 1954, it was recognized that *B. anthracis* produces toxins, the main reason the host feels sick or dies.
- Classified among the highest priority for bioterrorism agents by the CDC (Category A)

Common Human Exposure Routes:

- Cutaneous anthrax results from the introduction of the spore through a cut or abrasion on the skin. This is the most common manifestation of naturally occurring infections.
- Inhalation anthrax develops after anthrax spores enter the lungs and germinate.
- Gastrointestinal anthrax develops following the consumption of undercooked infected meat.

Likelihood of Secondary Transmission:

- Extremely low. Few reports of suspected person-to-person transmission, all of which have been limited to the cutaneous form of the disease

At-Risk Populations:

- Those performing certain activities, such as butchering or slaughter of infected animals, or the consumption of undercooked meat from those animals
- Occupational risk for farmers, veterinarians, tannery and wool workers, and laboratory personnel
- A threat as a bioterrorist weapon for susceptible populations

Vector and Reservoir Involved:

- None

Blood Phase:

- Symptomatic bacteremia and toxemia are common in systemic infections from gastrointestinal and inhalational anthrax. Bacteremia is detectable in fulminant cases of cutaneous anthrax.
- Bacteremia in asymptomatic individuals has not been described.

Survival/Persistence in Blood Products:

- Unknown

Transmission by Blood Transfusion:

- Theoretical; experimental transmission through blood has been demonstrated in animal models.

Cases/Frequency in Population:

- Uncommon in the US: seven cases of cutaneous anthrax reported to CDC (1980-2000) and an outbreak of bioterrorism-related anthrax with 22 confirmed or suspected cases (2001). One case of inhalation anthrax was found in a man who made traditional African animal skin drums (2006).
- Anthrax can be found globally in temperate zones but it is more often a risk in countries with less standardized and less effective health programs. Areas at high risk are Central and South America, Southern and Eastern Europe, Asia, Africa, the Caribbean and the Middle East.

Incubation Period:

- Cutaneous anthrax: usually 5-7 days (range: 1-12 days)
- Inhalation anthrax: usually 1-7 days (in some cases up to 42 days)
- Gastrointestinal anthrax: usually 1-6 days

Likelihood of Clinical Disease:

- Very high
- Presence of antibodies to *B. anthracis* without previous clinical disease has been reported.

Primary Disease Symptoms:

- Cutaneous anthrax: Small painless (often pruritic) papule that quickly enlarges and develops a central vesicle or bulla that later forms a black scab usually

with extensive surrounding swelling. Regional lymphadenopathy and lymphangitis are often present. Systemic symptoms, including fever, malaise, and headache, also may occur.
- Inhalation anthrax: Early symptoms are nonspecific with myalgia, fever, and malaise. Two to three days later, respiratory symptoms develop (severe dyspnea and hypoxemia). Shock may occur in the second phase. Hematogenous spread can result in lesions in other organ systems.
- Gastrointestinal anthrax: Includes two clinical forms, oropharyngeal and intestinal. The oropharyngeal form consists of edematous lesions in the oropharynx, which progress to pseudomembranous necrotic ulcers. Cervical lymphadenopathy, pharyngitis, and fever may be present. In the intestinal form, symptoms may include fever, nausea and vomiting, anorexia, abdominal pain and tenderness, and progress to hematemesis and bloody diarrhea. Hemorrhagic ascites may be present. The disease may progress to toxemia, cyanosis, shock, and death. Mild cases of gastrointestinal anthrax may present as gastroenteritis with diarrhea as the only symptom.

Severity of Clinical Disease:

- Cutaneous anthrax: Severe if not treated with antibiotics
- Inhalation and gastrointestinal anthrax: Severe

Mortality:

- Cutaneous anthrax: Mortality rate is <1% with antibiotic therapy. Without appropriate therapy, it can be as high as 20%
- Inhalation anthrax: Usually fatal (85% or higher). If treated early in the course of disease, the mortality rate is lower. During 2001 bioterrorism event, 55% responded to antibiotic treatment.
- Gastrointestinal anthrax: Fatality rate is unknown but is estimated to range from 25-60%.

Chronic Carriage:

- None

Treatment Available/Efficacious:

- Sensitive to a wide range of antibiotics. Ciprofloxacin, doxycycline, and penicillin are FDA approved for the treatment of anthrax in adults and children.

Agent-Specific Screening Question(s):

- No specific question is in use.
- Not indicated because of a low incidence of disease, and it is unlikely that persons with symptomatic *B. anthracis* infection would pass the donor screening questionnaire and physical exam.
- 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.
- Primary approach is direct culture of clinical specimens
- An FDA-licensed immunochromatographic diagnostic test is available for testing of nonhemolytic *Bacillus* isolates cultured on sheep blood agar plates. This can be used for the presumptive identification of *B. anthracis* isolates.
- Other tests include susceptibility to gamma phage lysis, real-time PCR assay, a direct fluorescent assay, and time-resolved fluorescent assay for detection of *B. anthracis*-specific antigens.

Currently Recommended Donor Deferral Period:

- The FDA recommends:
  - Current confirmed medical diagnosis of anthrax of any form: Defer until a full course of an appropriate treatment is completed and the condition is resolved.
  - Proven bacterial colonization in a well person: Defer until a full course of prophylaxis with an appropriate antibiotic is completed.
  - Presence of a skin lesion suspected to be anthrax: Defer until either the lesion is later shown not to be a result of anthrax or the lesion is confirmed as cutaneous anthrax and the person completes a full course of an appropriate treatment and the condition is resolved.

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:

- None

Suggested Reading:

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