**Microbiology**

- **Genus Bacillus**: aerobic or facultatively anaerobic spore-forming rods, staining gram-positive or gram variable.
- Ubiquitous in nature
- Optimal temperature for growth is 25-37°C.
- In vegetative form, bacilli are killed in 1 hour of moist heat at 55°C.
- Spores may withstand boiling for hours.

**Clinical manifestations**

- Overall, rarely associated with actual infections and frequently isolated as culture contaminant.
- Risk factors: IV drug abuse, sickle cell disease, foreign bodies including intravascular catheters, immunosuppression from malignancy, neutropenia, corticosteroid therapy and AIDS.
- Food poisoning, localized infection related to trauma (ocular), deep-seated soft tissue infections, and systemic infections (meningitis, endocarditis, osteomyelitis, recurrent bacteremia).

**Epidemiology**

- Usually found in decaying organic matter, dust, soil, vegetables and water (some species are part of the normal flora).
- Food poisoning by *B. cereus* accounted for 1-3% of outbreaks of bacterial food poisoning in the late 1970’s and early 1980’s (sources including rice, meat loaf, turkey loaf, sprouts, mashed potatoes, beef stew and apples).
- Lesser known outbreaks:
  - Contaminated ventilator equipment.
  - Well-spiced meat dishes (Hungary).
  - Hot chocolate in vending machines.
  - Contaminated dialysis equipment.
  - Part of polymicrobial infection of wound or burn infections.
  - Contaminated heroin and paraphernalia.

**Pathogenesis**

- Different species produce a variety of extracellular products including antimicrobial substances, enzymes, pigments and toxins in a few species.
- Enzymes include: amylase, collagenase, hemolysin, lecithinase, phospholipase, protease and urease.

**Pneumonia**

- Rare pulmonary pathogen in compromised host.
- A variety of presentations have been reported including necrotizing pneumonitis, infections with fulminant courses, empyema. Generally indistinguishable from other bacterial pneumonias.
- Outcome is poor.

**Food poisoning**

- Emetic (1-6 hours after exposure, acts like staphalococcal food poisoning)
- Diarrheal (10-12 hours after exposure, generally with meats or vegetables, acts like C. perfringins)
- Proof is in the food, not the stool (b/c asymptomatic carriage in stool 14-43%)
- Fried Rice: In Chinese restaurants, rice is cooked and then allowed to cool in the ambient temperature, and kept at that temperature overnight, and then the next day cooked with a beaten egg. Such practices result in survival and proliferation of spores with the greatest heat resistance. The spores germinate in the cooked rice, and there is a rapid growth of vegetative bacteria.
- Illness is self limiting and treatment is symptomatic w/rehydration as needed.
- In terms of food preparation, should either be maintained at 60°C or higher or cooled rapidly to below 8-10°C to prevent growth or greatly reduce its rate.

**Bacteremia and Septicemia**

- Bacteremia is common
- Blood culture isolation is not always indicative of infection.
- Beware of hemolytic anemia in drug abuser with SC sickle cell disease.
- Can be complication in patient with implanted IV catheters; removal of implanted device effects the cure. Vancomycin has been used to control the sepsis but failed to sterilize the catheter.
- When present in a single culture, may be asymptomatic, and may represent contamination by ubiquitous bacillus spores. And growth in one culture in someone with little or no illness, therapy is not immediately necessary.
<table>
<thead>
<tr>
<th>Species</th>
<th>Clinical Syndrome</th>
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<tbody>
<tr>
<td><em>Bacillus alvei</em></td>
<td>Sepsis, meningitis, pneumonia, empyema, bacteremia</td>
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<tr>
<td><em>Bacillus cereus</em></td>
<td>Bacteremia, pneumonia, ophthalmitis, osteomyelitis, endocarditis, soft tissue infections, meningoencephalitis, fulminant hepatitis</td>
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<tr>
<td><em>Bacillus circulans</em></td>
<td>meningitis</td>
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<td><em>Bacillus laterosporus</em></td>
<td>septicemia</td>
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<tr>
<td><em>Bacillus licheniformis</em></td>
<td>Intravascular catheter-acquired sepsis</td>
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<tr>
<td><em>Bacillus megaterium</em></td>
<td>Meningitis, bacteremia</td>
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<tr>
<td><em>Bacillus pumilus</em></td>
<td>Meningitis, bacteremia</td>
</tr>
<tr>
<td><em>Bacillus sphaericus</em></td>
<td>Peritonitis, pleuritis, pericarditis, pseudotumor of the lung, meningitis, bacteremia</td>
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<tr>
<td><em>Bacillus subtilis</em></td>
<td>Meningitis, otitis, mastoiditis, urinary tract infection, bacteremia, pneumonia, endocarditis, ventriculaoatrial shunt infection.</td>
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### Treatment

- **B. cereus** - Beta-lactams are rarely effective
- Non-*B. cereus* strains are susceptible to PCN, semisynthetic penicillins, and cephalosporins.
- Imipenem ciprofloxacin and gentamycin are highly active.
- Many strains are susceptible to tetracycline, chloramphenicol.
- Vancomycin is bactericidal at or near the same concentration at which it is bacteriostatic.
- Clindamycin-gentamycin has more synergy.
- Drug of choice in serious infections is vancomycin because *B. cereus* is most common isolate.
- Bacteremia in parenteral drug abusers, vancomycin or clindamycin can be used.
- Duration of treatment is about 7-14 days.
- Catheter removal is often required for cure of bacteremia in patients with implanted intravascular catheters.
- Osteomyelitis: clindamycin or vancomycin.

### Meninigitis and brain abscess

- Rare, only 15 case reported in English literature (immunocompromised patient with neoplasms), superficial tissues.
- Necrotizing fasciitis in sickle cell disease and in leukemic patients; abx not enough, and multiple surgical debridement is necessary.
- Acute and chronic forms of osteomyelitis are infrequent causes of bacillus infections.
- *Vertebral osteomyelitis* has been reported in drug abusers.

### Soft tissue and musculoskeletal infections

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### Ocular infections

- In particular, *B. subtilis* has been known to cause dacryocystitis, conjunctivitis, keratitis, iridocyclitis, panophthalmitis, orbital abscess.
- *B. cereus* is a primary pathogen of ocular infections, often with foreign body present, and observed with metal projectile injuries.
- Massive destruction of vitreal and retinal tissue of the eye, w/ visual compromise within the first 12-48hours of inoculation. Presence of progressive corneal deterioration and ring abscess formation is a complication of panophthalmitis caused by *B. cereus*, pathognomonic for *B. cereus* infection. The ring abscess is noted within 48 hrs after periorbital edema, proptosis, and corneal swelling are noted., with the vitreal infection spreading to the retina. Pt’s are usually systemically ill w/ fever and leukocytosis.
- Have high suspicion of bacillus as organism in ocular infection after trauma in the setting of drug abuse. Early aggressive measures are utilized, including early vitrectomy with vitreal instillation of antibiotics.
- Tx: aminoglycosides locally and systemically, but are inadequate. Clindamycin and vancomycin are appropriate empirically.
- Steroids and early vitrectomy have been recommended for managing sight-threatening endophthalmitis w/ poor prognosis in terms of vision preservation.

### References

http://www.biology.missouri.edu/courses/Bio10/eubacteriadiversity.html