Microbial Diseases of the Cardiovascular System

Bacterial Infections

The cardiovascular system

- Superior vena cava (main upper vein)
- Aorta (main artery)
- Lung
- Capillaries in lung
- Inferior vena cava (main lower vein)
- Liver
- Intestine

- Heart
- Spleen
- Stomach
- Kidneys
- Capillaries in intestines

The lymphatic system

- Lymphatic vessels drain interstitial fluids from tissues
- Lymph nodes contain lymphocytes and antigen-presenting cells
**Septicemia** - Proliferation of bacteria in the bloodstream

- Release of microbial products may lead to *septic shock*
- Often nosocomial
- Gram-negative sepsis - Due to release of *lipopolysaccharide*
- Gram-positive sepsis - *Enterococcus faecalis, E. faecium, Streptococcus agalactiae*
- *Puerperal sepsis*
  - Infection of the uterus, typically by *Streptococcus pyogenes*, leading to *peritonitis* and septicemia
  - Control of puerperal sepsis was a significant outcome of antisepsis in delivery

**Bacterial Endocarditis**

- Colonization of the *endocardium*
- *Subacute bacterial endocarditis*
  - Typically infection with α-hemolytic streptococci
  - Risk enhanced by pre-existing damage or congenital valve defects
- *Acute bacterial endocarditis*
- *Rheumatic fever* - Autoimmune damage associated with *Streptococcus pyogenes* infection
- Persons with damaged heart valves may be given antibiotics prior to procedures that may release bacteria into the bloodstream (e.g., PAP test, dental work)

**Tularemia and Brucellosis**

- *Zoonotic* agents capable of multiplication in macrophages
- Members of the bioweapons “A list”
**Anthrax**

- Infection with *Bacillus anthracis*
- Mostly an infection of livestock, caused by ingestion of *B. anthracis* endospores
- Obviously A list, due to lethality of *inhalational anthrax*
- Most human cases are *cutaneous*

**Gangrene**

- Multiplication of anaerobic bacteria, especially *Clostridium perfringens*, in *necrotic* tissue
- Feared outcome of traumatic injury, as in combat
- Therapy may involve
  - Removal of necrotic tissue
  - *Hyperbaric* treatment
“The marvellous thing is that it’s painless,” he said. “That’s how you know when it starts.”

“Is it really?”

“Absolutely. I’m awfully sorry about the odor though. That must bother you.”

“Don’t! Please don’t.”

“Look at them,” he said. “Now is it sight or is it scent that brings them like that?”

_The Snows of Kilimanjaro_
Ernest Hemingway

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**Vector-borne Bacterial Infections**  
**Plague**

- Agent is *Yersinia pestis*, endemic in rats and wild rodents
- Transmitted by fleas
- Manifests as
  - *Bubonic plague*, characterized by enlarged lymph nodes
  - *Septicemic plague*, leading to septic shock
  - *Pneumonic plague*, rapidly fatal, may contribute to human-human transmission
- Current low incidence in the U.S. is mostly transmission from wild rodents

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**U.S. geographic distribution of human plague, 1970-1997**
Vector-borne bacterial infections

Relapsing fever and Lyme disease

- Caused by the spirochaete *Borrelia* and transmitted by ticks
- Seasonal pattern of incidence reflects vector transmission
- Persistent infection with *B. burgdorferi* can lead to immunopathologies
- The first symptom of Lyme disease is a characteristic rash occurring at the bite area

Vector and Agent of Lyme disease

- The deer tick *Ixodes scapularis*
- The spirochaete *Borrelia burgdorferi*
Life cycle of the deer tick, *Ixodes scapularis*

- Adults feed on deer and male
- Female tick lays eggs
- Uninfected six-legged larva hatches from egg and develops
- Larva feeds on small animal, becoming infected
- Larva is dormant
- Nymph feeds on several or human, transmitting infection
- Nymph develops into adult tick
- Year 1—Spring

U.S. incidence of Lyme disease, 2000

Vector-borne bacterial infections

*Erlichiosis*

- *Erlichia* are obligately intracellular bacteria that multiply in leukocytes
- Transmitted by ticks
- Two distinct forms
  - *Human granulocytic erlichiosis*
  - *Human monocytic erlichiosis*
- Usually a mild infection, but may be severe in compromised patients
Vector-borne bacterial infections

**Typhus**

- **Epidemic typhus**
  - Agent is *Rickettsia prowazekii*
  - Vector is *Pediculus humanis*, the human body louse
  - Epidemics occur in crowded conditions, as accompany warfare
- **Endemic murine typhus**
  - Agent is *Rickettsia typhi*
  - Vector is *Xenopsylla cheopis*, the rat flea
  - Occurrence is sporadic

**Rocky Mountain spotted fever**

- Also known as *tick-borne typhus*
- Agent is *Rickettsia rickettsiae*
- Vector is usually *Dermacentor variabilis*, the dog tick
- *Rickettsias* can be transmitted between ticks by *transovarian passage*

U.S. geographic distribution of Rocky Mountain spotted fever, 1994-1998
Life cycle of *Dermacentor*

1. An infected adult female tick lays eggs.
2. Eggs hatch and six-legged larvae develop.
3. Six-legged larva takes blood meal from small mammal, infecting it, and then develops into nymph.
4. Nymph takes blood meal from human, infecting it, or her, and then develops into adult.
5. Adult female takes another blood meal and mates.

Adult female (size: 3 mm)