BACTERIAL INFECTION

RATIRATH SAMOL, MD

content

- Pyogenic gram positive cocci
- Bacterial infection of childhood
- Sexually transmitted bacterial disease
- Enteropathogenic bacteria
- Clostridial infection
- Bacterial infection with animal reservoirs or insect vectors
- Bacterial infection with immunocompromised host
- Filamentous bacteria
- Mycobacterial infection
- Chlamydia infection
- Mycoplasma infection
- Rickettsia infection

Pyogenic gram positive cocci

- Staphylococcal infection
  - coagulase positive (S. aureus)
  - coagulase negative (S. epidermidis, S. saprophyticus)
- Streptococcal infection
  - S. pyogenes (group A)
  - S. agalactiae (group B)
  - S. pneumoniae
  - S. mutans

Staphylococcus spp.

Streptococcus spp.
Staphylococcus aureus

- Furuncles
  - infection in and around hair follicles
  - common in scalp, face, axillary
- Carbuncles
  - infection around hair follicle and produce draining sinuses
- Hydradenitis suppurativa
  - infection in sweat gland

- Osteomyelitis
  - infection in bone
- Toxic shock syndrome (TSS)
  - infection in surgical wound, tampons produce high fever, nausea, vomiting and shock

- Food poisoning
  - diarrhea, nausea, vomiting
  - symptom present < 6 hours after contaminated food

- Staphylococcal scalded skin syndrome (SSSS)
  - severe skin infection
  - organism produce exfoliatin that destroys granulosa of epidermis → bullae, rupture, skin scald
  - other organs: lung, heart valve, bone

SSSS
Staphylococcus epidermidis
- causes opportunistic infections in catheterized patients, patients with prosthetic cardiac valves, and drug addicts.

Staphylococcus saprophyticus
- common cause of urinary tract infections in young women.

Streptococcal infection
- 3 types
  - α hemolytic streptococci
    eg. S. pneumoniae, S. viridans, S. mutans
  - β hemolytic streptococci
    eg. S. pyogenes (group A), S. agalactiae (group B)
  - γ hemolytic streptococci (non-hemolytic)
    eg. S. faecalis (group D)

α-hemolytic streptococci
- S. pneumoniae is a common cause of community-acquired pneumonia and meningitis in adults
- S. viridans are part of the normal oral flora but are also a common cause of endocarditis
- S. mutans is the major cause of dental caries

β-hemolytic streptococci
- S. pyogenes (group A)
  - pharyngitis
  - scarlet fever
  - erysipelas
  - impetigo
  - cellulitis

Pharyngitis
- Infection in throat (tonsillitis)
- Clinical: high grade fever, sore throat
- Complication:
  - glomerulonephritis, rheumatic fever
  - cross reaction of immune system to M protein of bacteria
**Scarlet fever**
- Common in childhood
- Erythematous rash at trunk, extremities and face *except* around the mouth (circumoral pallor), strawberry tongue
- Cause by erythrogenic toxin

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**Erysipelas**
- Erythematous rash, rapid distribution at face, particularly both cheeks
- Rash at trunk, extremities (uncommon)

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**Impetigo**
- Infection in epidermis
- Erythematous papule → pustule
- May be caused by S. pyogenes or S. aureus
**Cellulitis**
- Infection in deep dermis
- S. pyogenes invade through wound
- Pustule in deep dermis
- Clinical: fever, erythematous skin lesion

**β-hemolytic streptococci**
- S. agalactiae (group B)
  - meningitis
  - chorioamnionitis
  - septicemia

**Bacterial infection of childhood**
- Diphtheria
- Pertussis (Whooping cough)
- Haemophilus influenzae infection
- Neisseria meningitidis infection

**Diphtheria**
- Caused by Corynebacterium diphtheriae (gram positive bacilli)
- Transmitted as respiration
- Immunization with diphtheria toxoid (formalin-fixed toxin) does not prevent colonization with C. diphtheriae but protects immunized people from the lethal effects of the toxin.
Diphtheria

- Tracheal colonization may lead to
  - Mucosal erosion, exudate (pseudomembrane) → obstruct airway
- Toxin-mediated damage to the heart, nerves, liver, or kidneys

Pertussis

- Bordetella pertussis infection (gram negative coccobacilli)
- Common in childhood (<5 yrs)
- Causes as laryngotracheobronchitis, ciliated respiratory epithelium necrosis
- Clinical: severe cough (whooping)

Haemophilus influenzae infection

- Gram negative coccobacilli
- 6 serotype (a-f), type b causes as severe disease
- Caused by
  - pneumonia
  - meningitis
  - upper respiratory infection (otitis media, sinusitis, epiglottitis)

Neisseria meningitidis infection

- Gram negative diplococci
- Caused by
  - meningitis (fever, stiff neck, headache, shock and dead)
  - vasculitis (petechiae and purpura at skin and internal organs)

Meningitis

Bacterial meningitis

- Streptococcus pneumoniae 50%
- Neisseria meningitidis 25%
- Group B streptococci 15%
- Listeria monocytogenes 10%
- Haemophilus influenzae (type b) <10%

From Harrison ed. 16th
Sexually transmitted bacterial disease

- Gonorrhea
- Chancroid (soft chancre)
- Granuloma inguinale
- Syphilis

Gonorrhea

- Nesseria gonorrhoeae (gram negative diplococci)
- Caused by
  - male: urethritis, epididymitis
  - female: endometritis, salpingitis, PID
  - neonatal infection: conjunctivitis, blindness

Chancroid (soft chancre)

- Haemophilus ducreyi (gram negative bacilli)
- Clinical feature:
  - Painful multiple genital ulcer and dirty based ulcer
  - 50% inguinal lymphadenitis
Granuloma inguinale
- Calymmatobacterium granulomatis (gram negative coccobacilli)
- Clinical feature:
  - raised, soft red papule and ulcer at genital area → chronic inflammation → scar

Syphilis
- Treponema pallidum (spirochete)
- 3 stages
  - primary syphilis
  - secondary syphilis
  - tertiary syphilis

Syphilis
- Primary syphilis
  - chancre: painless, a clean based ulcer and regression 3-6 weeks
  - inguinal lymphadenopathy
  - microscopic: chronic inflammation and organisms

Syphilis
- Secondary syphilis
  - systemic dissemination to many organs eg. skin, LN, meninges, liver, mucous membrane
  - common presentation: rash at trunk, extremities, palm, sole appears from 2 wks to 6 months after chancre heals

Syphilis
- Secondary syphilis
  - condyloma lata (exudative plaques in perineum, vulva, scrotum)
  - white mucous patch (rash at mucous membrane at mouth, genital organs)
  - fever, anorexia, alopecia
  - microscopic: chronic inflammation, many organisms
Secondary syphilis

Syphilis

- Tertiary syphilis
  - 1/3 of untreated patient develop tertiary syphilis (no organisms)
  - syphilitic aortitis (80%) → aortic regurgitation, aneurysm
  - neurosyphilis → paralysis, seizure
  - gumma: granulomatous inflammation in any organs eg. skin, bone, liver

Tertiary syphilis

syphilitic aortitis with aneurysm

Congenital syphilis

Tertiary syphilis

- Intrauterine infection of fetus
- Common in primary and secondary syphilis (many organisms) of pregnant women
- Organisms transferred to fetus by placenta
- Causes late abortion, stillbirth, or death soon after delivery
- 2 stages
  - early syphilis
  - late syphilis

Congenital syphilis

- early syphilis (< 2 yrs)
  - extensive cutaneous rash containing many spirochetes
  - Osteochondritis with collapse of the bridge of the nose (saddle nose)
  - Periostitis with bowing of the tibia

Congenital syphilis

- late syphilis (> 2 yrs)
  - Hutchinson triad
    - eighth nerve deafness
    - interstitial keratitis (blindness)
    - notched central incisors (Hutchinson teeth)
notched central incisors

Laboratory diagnosis
- Nontreponemal antibody test
  - detect Ab against cardiolipin in blood
  - RPR, VDRL
  - screening test, follow up
  - false positive: SLE, acute infection, leprosy
  - cure \( \rightarrow \) negative result

Enteropathogenic bacteria
- Antitreponemal antibody test
  - detect Ab against T. pallidum
  - FTA-Abs, MHATP
  - positive after infection 4-6 wks and continuous positive until cure

Salmonella infection and typhoid fever
- Gram negative bacilli
- Salmonella typhi
  - caused by typhoid fever
  - contaminated food and water
  - organisms contaminates in feces of carrier
Salmonella infection and typhoid fever

- Salmonella typhi (typhoid fever)
  - septicemia, fever, abdominal pain
  - bacterial replication in macrophages of Peyer patches of terminal ileum → nodule
  - ulcer along the intestine → mucous bloody diarrhea → shock

Shigella infection

- Gram negative bacilli
- S. boydii, S. flexneri, S. dysenteriae
- Infection small and large intestine
- Transmitted by fecal-oral route
- s/s: dysentery (cramping, tenesmus, mucous bloody diarrhea)
- Microscopic: ulcer of intestine covered by neutrophils, enlarged mucosal lymphoid follicles

Campylobacter infection

- Comma shaped, flagellated gram negative
- Common pathogen: C. jejuni
- Transmitted by contaminated food
- Inflammation of jejunum continues to anus
- s/s: diarrhea, fever
- Microscopic: ulcer, neutrophils

Cholera

- Vibrio cholerae (comma shaped, flagellated gram negative)
- Many serotypes (01 serotype=pathogen)
- s/s: massive rice-watery diarrhea
- Gross: non-specific
- Micro: scant neutrophils

Mechanism of cholera
<table>
<thead>
<tr>
<th>Escherichia coli</th>
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<tbody>
<tr>
<td>Gram negative bacilli</td>
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<tr>
<td>Flora in lower intestines (colon)</td>
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<tr>
<td>Assists with waste processing, vitamin K production, and food absorption</td>
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<tr>
<td>Cause several intestinal and extra-intestinal infections eg. urinary tract infections (UTI), meningitis, pneumonia</td>
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<tbody>
<tr>
<td>Bacteria produce toxins → damage enterocytes and vascular endothelial cells</td>
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<td>Clinical features: - abdominal pain and diarrhea</td>
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<th>Helicobacter pylori</th>
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<tr>
<td>Curvilinear gram negative bacilli</td>
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<tr>
<td>Caused by chronic gastritis, peptic ulcer</td>
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<tr>
<td>Clinical features: epigastric pain, nausea, vomiting</td>
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<tr>
<td>Associated with gastric carcinoma and lymphoma</td>
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<th>Helicobacter pylori</th>
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<tr>
<td>HELICOBACTER PYLORI</td>
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<td>HELICOBACTER PYLORI (SILVER STAIN)</td>
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<thead>
<tr>
<th>Clostridial infection</th>
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<tr>
<td>Clostridium perfringens</td>
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<tr>
<td>Clostridium tetani</td>
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<tr>
<td>Clostridium botulinum</td>
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<tr>
<td>Clostridium difficile</td>
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**Clostridium perfringens**

- Gas gangrene (myonecrosis)
  - organisms invade through ulcer
  - toxin destroy RBC, platelet, muscle
  (myonecrosis with gas forming)

- Food poisoning
- Necrotizing enteritis
  - enterotoxin of C. perfringens (type C)
  induces necrosis and hemorrhage of small intestine
  - s/s: abdominal pain, n/s, bloody diarrhea, dead (24 hrs)

**Clostridium tetani**

- Caused by tetanus
- Organisms invades to the wound
- Tetanus neonatorum: contaminated instruments

**Clostridium botulinum**

- grows in inadequately sterilized canned foods and releases a potent neurotoxin (botulinum) that blocks synaptic release of acetylcholine and causes a severe paralysis of respiratory and skeletal muscles

**Clostridium difficile**

- overgrows other intestinal flora in antibiotic-treated patients, releases toxins, and causes pseudomembranous colitis
Bacterial infection with animal reservoirs or insect vectors

Pseudomembranous colitis

Bacterial infection with animal reservoirs or insect vectors

Plague
- Caused by Yersinia pestis (gram negative intracellular bacilli)
- Reservoir: fleas
- Infected by fleas bite
- 3 syndrome
  - bubonic plague
  - septicemic plague
  - pneumonic plague

Anthrax
- Bacillus anthracis (gram positive bacilli)
- Reservoirs: goat, sheep, cattle, dog, pig
- Spores form in soil, dead animals
- 3 group
  - cutaneous anthrax
  - inhalational anthrax
  - gastrointestinal anthrax

Plague
- Cutaneous anthrax
- Septicemic plague
- Respiratory droplet transmission
**Anthrax**

- Cutaneous anthrax (95%)
  - Spores invade wound → painless papule and vesicle → ulcer, regional enlarged LN → cure
- Inhalational anthrax
  - Inhaled spores → hemorrhagic mediastinitis → sudden dead
- Gastrointestinal anthrax (rare)
  - Eating spores contaminated meat → GI symptom → high mortality rate

**Leptospirosis**

- Leptospira interrogans (spirochete)
- Reservoir: rodent, cattle, cat, dog
- Bacteria secrete in animal urination and contamination in environment
- Transmitted by abrasion wound

**Leptospirosis**

- Composed of 2 symptom
  1. Anicteric leptospirosis
     - Leptospiremic phase: fever, headache, myalgia, hepatosplenomegaly
     - Leptospiruric phase: aseptic meningitis
  2. Severe leptospirosis (Weil syndrome)
     - Severe jaundice, hepatosplenomegaly
     - Acute renal failure (dead)
     - Bleeding in GI, skin, brain

**Cat-scratch disease**

- Bartonella henselae (gram negative bacilli)
- Transmitted by scratch or bite of cat
- S/s: red papule or pustule skin, enlarged LN (axilla, neck)
- Microscopic: granulomatous inflammation and abscess

**Bacterial infection with immunocompromised host**
Bacterial infection with immunocompromised host

- Pseudomonas infection
- Legionnaires infection

Pseudomonas infection

- Pseudomonas aeruginosa (gram negative bacilli)
- Nosocomial infection
- Common in severe burn, cystic fibrosis, leukopenia

Pseudomonas aeruginosa

- Necrotizing pneumonia
- Keratitis (contact lens)
- Vulvular disease (IVDU)
- Otitis externa (swimming)
- Ecthyma gangrenosum (severe burn)

Legionnaires infection

- Legionella pneumophila (gram negative bacilli)
- Reservoir: water source, air condition
- 2 symptom
  - pontiac fever (URI, fever → cure)
  - legionnaires disease (severe pneumonia)

Legionnaires infection

- legionnaires disease (severe pneumonia)
  - scattered lung lesions, particularly bronchiole and alveoli
  - microscopic: mixed inflammatory cells, vasculitis, thrombosis

Filamentous bacteria
Filamentous bacteria

- Actinomycosis
- Nocardiosis
- Mycetoma (actinomycotic mycetoma)

Order Actinomycetales (Actinomycetes)

- Aerobic actinomycetes
  - cell wall with mycolic acid
    - Nocardia, Mycobacterium, Corynebacterium
  - cell wall without mycolic acid
    - Actinomadura, Streptomyces
- Anaerobic actinomycetes
  - cell wall without mycolic acid
    - Actinomyces, Propionibacterium, Lactobacillus

*เชื้อที่มี mycolic acid จะยึดติด AFB และ modified AFB

Actinomycosis

- Actinomyces israelii
- Flora in oral, pharynx, GI, vagina
- Caused by lump jaw, osteomyelitis, intra-abdominal infection, pelvic inflammatory disease (IUD)

Actinomycosis

- Gross: sulfur granules (grains)
- Microscopic: organisms surrounded by neutrophils, histiocytes, giant cells
- Special stains (GMS): filamentous shaped bacteria

Actinomycosis

sulfur granules
**Actinomycosis**

- Cluster of filamentous bacteria
- Filamentous bacteria by GMS

**Nocardiosis**

- Opportunistic infection in immunocompromised host
- Nocardia asteroides
  - lobar pneumonia or abscess
  - organisms found in soil
  - transmitted by inhaled organisms
  - s/s: fever, cough, dyspnea

**Nocardiosis**

- Microscopic: neutrophil, macrophage, necrosis, organisms and may be giant cells
- Special stains: modified acid fast stain (red filament or branching)

**Nocardia spp. (Modified AFB stain)**

**Mycetoma**

- Actinomycotic mycetoma: caused by
  - Actinomadura spp.
  - Streptomyces spp.
  - Nocardia spp.
- Eumycotic mycetoma: caused by
  - fungi e.g. Pseudallescheria spp., Madurella spp.

**Actinomycotic mycetoma**

- Localized multiple nodules with sinuses and swelling lesions
- Involving cutaneous and subcutaneous tissues, fascia and bone
- Occurs on foot or hand
- Results from traumatic implantation of soil organisms into the tissues
Actinomycotic mycetoma

- Lesions are composed of suppurating abscesses and sulfur granules (grains)
- Microscopic: organisms surrounded by neutrophils, histiocytes, giant cells
- Special stains (GMS): filamentous shaped bacteria

Mycobacterial infection

- Mycobacterium spp.
  - Mycobacterium tuberculosis complex
    - M. tuberculosis, M. bovis, M. africanum, M. microti
    - Causes pulmonary and extrapulmonary tuberculosis
  - Nontuberculous mycobacteria (NTM)
    - Mycobacterium avium complex (MAC)
      (M. avium, M. intracellulare)
  - Mycobacterium leprae

Pulmonary tuberculosis

- Caused by M. tuberculosis
- Classified 2 types
  - Primary pulmonary tuberculosis
  - Secondary pulmonary tuberculosis
Primary pulmonary tuberculosis

- Primary infection at lungs composed of "Ghon complex"
  - Lung infection → Ghon focus
  - Infection of hila node
- Most of infected persons → healed scar
- Clinical : non specific

Secondary pulmonary tuberculosis

- reactivation or reinfection of primary TB with asymptomatic
- Common infection at high O2 (apex of lung)
- Severe lung damage and produces cavity

Secondary pulmonary tuberculosis

- Clinical course
  - chronic cough, low grade fever, weigh loss, anorexia
  - recovery if normal immune or treatment
  - lymphatic or hematogenous spread to other organs eg, liver, spleen, pancreas → miliary TB

Secondary pulmonary tuberculosis

Miliary TB
Caseous granulomas

Pulmonary TB

AFB stain

Extrapulmonary tuberculosis

- TB at any organs eg. LN, GI, skin, meninges, bone, liver spleen etc.
- Transmitted by TB lung spreading or direct invasion to any organs
- Gross and microscopic similar to TB lung

Diagnostic test for TB

- Special stains
  - AFB: reddish bacilli
  - Gram stain: indistinct gram positive bacilli
- Culture
- PCR

Nontuberculous mycobacteria

- Common in immunocompromised host eg. AIDS, leukemia
- Organisms contain in soil and water
- M. avium complex (MAC)
- Infection in any organs eg. lung, GI, bone
- s/s: depend on location
Nontuberculous mycobacteria

- Gross: non-specific
- Microscopic: clusters of macrophages contain many organisms (AFB stain)

MAC

Leprosy

- Mycobacterium leprae
- Transmitted by respiration
- Causes skin lesion
  - tuberculoid leprosy
  - lepromatous leprosy

Tuberculoid leprosy

- Asymmetry erythematous plaque with sharp outer margins fading centrally to a flattened clear zone of healing that is rough, anhidrotic, hairless, hypopigmented, and anesthetic
- Muscle atrophy, ulcer, contracture
- Slow progressive
- Micro: granulomatous inflammation, rare organisms

More severe

- The early lesions of lepromatous leprosy are multiple, symmetrically distributed, erythematous ill-defined macules and papules
- Muscle atrophy
- Micro: clusters of macrophages containing organisms (AFB stain)
Lepromatous leprosy

Chlamydia infection

Chlamydia infection

Chlamydia trachomatis

- Chlamydia trachomatis
- Chlamydia psittaci
- Chlamydia pneumoniae

Chlamydia psittaci

- Caused by animal disease
- Human infected by respiration of secretion of affected animal
- Clinical features: upper respiratory tract infection, atypical pneumonia

Chlamydia pneumoniae

- Transmitted by respiration
- Caused by atypical pneumonia
- Micro: lymphocytes infiltration in interstitium
Mycoplasma infection

M. pneumoniae
- No cell wall → no Gram staining
- Transmitted by respiration
- Common in child, young adult
- Caused by
  - pharyngitis
  - sinusitis
  - laryngotracheobronchitis
  - atypical pneumonia

Rickettsia infection

Animal reservoirs: tick, mite, flea, louse
- 3 groups:
  - spotted fever group
  - typhus group
  - scrub typhus group

Spotted fever group
- Rocky Mountain spotted fever
  - R. rickettsii
  - Tick bite
- Rickettsiapox
  - R. akari
  - Mite bite

Typhus group
- Epidermic typhus
  - Brill-Zinsser disease
    - R. prowazekii
    - Louse feces
- Murine typhus
  - R. typhi
  - Rat flea feces
Scrub typhus group

- Scrub typhus
  - *Orientia tsutsugamushi*
  - Chigger bite

Rickettsia infection

- Pathology
  - destroy arteriole and capillary
  - necrotizing vasculitis
- spotted fever and scrub typhus groups: eschar
- typhus group: no eschar

eschar

THE END