Bacterial Respiratory Infection

(3rd Year Medicine)

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The respiratory tract is the most common site of body exposed for infection by pathogens and opportunistic pathogens. RT site becomes infected frequently because it comes into direct contact with the physical environment and is exposed continuously to many microorganisms & their spores in the air. Smoke, dust & human air droplets. It has been calculated that the average individual inhaled & ingests at least 8 microbial cells per minute or 10,000 per day.
Before a **Respiratory Disease** is developed, the following conditions need to be met:

- There must be a **sufficient number** or "dose" of infectious agent inhaled.
- The infectious organism must remain **alive and viable** while in the air.
- The organism must be **deposited on susceptible respiratory mucosa & attached**.
- The infectious agent must **overcome the host immune system**.
- The importance role of normal flora
Most infections are mixed Viruses plus Bacteria

- Common Cold: Rhinoviruses, Coronaviruses, Adenoviruses, Myxoviruses, Echoviruses, Coxsackie A and B, Echoviruses, *M. pneumoniae, C. pneumoniae*
- Dental caries: *S. mutans*
- Thrush: *C. albicans*
- Trench mouth: *Treponema vincentii, Fusobacterium fusiforme*
- Stomatitis: Herpes Simplex Virus
- Pharyngitis: Adenovirus, Herpes Simplex Virus, Coxsackieviruses, *S. pyogenes, C. diphtheriae*
- Otitis Media: *S. pneumoniae, H. influenzae, M. catarrhalis*
- Otitis Externa: *P. aeruginosa*
- Sinusitis: *S. pneumoniae, H. influenzae*
- Croup: Parainfluenza viruses, Respiratory Syncytial virus
- Epiglottitis: *H. influenzae*
- Whooping Cough: *Bordetella pertussis*
- Bronchitis: Parainfluenza viruses, Respiratory Syncytial virus, Influenza viruses, *M. pneumoniae, C. pneumoniae*
- Bronchiolitis: Respiratory Syncytial Virus
Normal Bacterial Respiratory Flora

- Most of the surfaces of **nasopharynx, oropharynx, and trachea** are colonized by normal flora. These organisms are usually normal inhabitants of these surfaces and rarely cause disease (Fig. 1):

- **Common types >10%:** *Viridans Streptococci* (S. mutans, S. mitis), *Neisseria* (N. flava, N. sicca), *Haemophilus* /*Parahaemophilus*, *Corynebacteria*, *Anaerobic Bacteria* (*Bacteroides fragilis*, *Spirochities*).

- **Less Common <10/ Transients:** *Group A streptococci*, *H. influenzae*, *S. pneumoniae*, *Candida*, Gram-ve bacilli & other bacteria.
Common Bacteria Agents cause of Upper Respiratory Infections

- **Haemophilus influenzae** type b: Capsule, Lipooligosaccharides, invasive, Highly susceptible to cold & room and high temperatures. Autolysis rapidly.

**Clinical Features:** Rare Sore Throat, Common Otitis – Sinusitis, Conjunctivitis, Blood sepsis/Meningitis. Children (6 months-5 years), Fig.2, Hib-vaccine, polysaccharide-protein conjugate vaccine combined with diphtheria-tetanus-pertussis and Hepatitis B vaccines. starting after the age of 6 weeks.

- **Staph. aureus:** All ages, Sinusitis, Pneumonia, Conjunctivitis, Rare Sore Throat, Blood sepsis, Rare Meningitis. Staphylococcal pneumonia is a frequent complication following influenza infection. Infants, Elderly patients, immunosuppressed.
Fig. 2 Haemophilus influenzae 
Gram-stain: G-ve coccobacilli + fimentes

Haemophilus influenzae infections

- meningitis (type b)
- otitis media (nontypable)
- sinusitis (nontypable)
- epiglottitis (type b)
- tracheobronchitis (nontypable)
- bacteremia (type b)
- pneumonia (nontypable)
Streptococci infections

- The genus *Streptococcus* consists of gram-positive cocci, catalase-ve.. Human commensals & opportunistic pathogens Respiratory Tract.. Beta-H-streptococci group, Viridans Streptococci group

- Definitive identification of hemolytic pyogenic streptococci types based on the serologic reactivity of cell wall polysaccharide antigens (*Lancefield groups*).

- The most important groups are A, B, C, D, G, F

- **Group A Hemolytic Streptococcus** cause about 10% Pharyngitis-Tonsillitis/Sore Throat.. less Otitis—Sinusitis, Skin in all Children.. Virulence factors (Fig-4).

- Complication: Post-streptococcal diseases
S. pyogenes (Group A Hemolytic-1)

- **Groups A**: common human pathogens. Beta hemolytic reaction on blood agar (Fig-3).

- **Group A**: is one of the most frequent pathogens of humans. It is estimated that between 5-15% of normal individuals carry this bacterium, usually in the respiratory tract, without signs of disease as normal flora. Healthy Carriers

- **Streptococcal Infections**: Mostly occur in Children < 12 years. Begin as acute Pharyngitis/Tonsillitis. Also infection by contact with infected skin wound. **Strept. Diseases** (Fig-5)

- About 1-3% infected children may develop post-streptococcal complications.
Fig. 3 - Beta-Hemolytic Streptococci
Pathogenesis of Group A-2

- **Systemic infections** found mostly in children. *Strept. virulence* is related to cell structures, enzymes & toxins produced (Fig-5).

- It has ability to colonize and rapidly multiply and spread in host while resist phagocytosis due to the hyaluronic acid capsule + cell surface T, R, M-proteins. About 100 serotypes.

- Resistance & Immunity to infection developed by presence of specific M-protein antibodies.

- Infection may spread easily to other body sites. Children. Common sinusitis, otitis, blood sepsis. Skin. rarely pneumonia. Repeat Streptococcal Throat infection is common in young children. each 1-3 months.
Fig. 4 - Infections of Streptococcus pyogenes
Fig. 5- *Streptococcus pyogenes*

- Extracellular substance
- Capsule (hyaluronic acid)
- Cell membrane
- Peptidoglycan (cell wall) (group carbohydrate antigen: rhamnose, N-acetylg glucosamine)
- Pili M protein type antigen; lipoteichoic acid; R and T proteins

- Streptolysins
- NADase
- Hyaluronidase
- Streptokinases
- Streptodornases
- Pyrogenic exotoxins
Group A Streptococcus-3

- **Scarlet fever**: children.. begins as pharyngitis.. Few lysogenic strains producing **pyrogenic /erythrogenic exotoxins** (A,B,C).. Diffuse erythematous rash in **oral mucous membranes** (Red Tong) & **Skin**.. Results in lifelong immunity.

- **Pyoderma**: superficial localized blisters (**impetigo**) associated with **massive brawny edema**.

- **Cellulitis /Erysipelas**: Skin infection rapidly spread to subcutaneous tissues & lymphatic system.. highly communicable in children.. may cause later **Glomeronephritis**

- **Streptococcal Toxic Shock Syndrome**: Few strains.. Host systemic responses to increased circulating **pyrogenic toxins superantigens**.. High fever, Bacteriemia, Diarrhea, Shock & Organ failures, high fatal.
Scarlet Fever
Group A *Streptococcus*-4

- **Necrotizing fasciitis:** Few strains.. Wound infections.. Rapid & extensive necrosis in subcutaneous tissues & fascia.. associated with Bacteriamia, Endocarditis, Heart failure.. High fatality without rapid antibiotics treatment.

- Rarely **Puerperal fever** .. blood sepsis (caused mostly **Group B Streptococcus**). .. infected injured uterus after delivery.. neonatal sepsis.

- **Post streptococcal diseases:**

- **Rheumatic fever & Glomerulonephritis:** followed repeat throat infection ..Autoimmununological reactions..

- Both diseases and their pathology are not due to dissemination of bacteria, but to late **immunological reactions to Group A streptococcal antigens**.. mainly Cell wall antigens & M-protein.
Diagnosis & Treatment

- **Lab Diagnosis:** Culture on sheep blood agar. Hemolytic Strept. Type confirmed by using specific antistreptococcal sera by slide agglutination test.

- **Detection Specific Antibodies:** 2-4 weeks after throat or skin infection.. Antistreptolysin 0 (ASO) titer > 240 IU, positive Streptokinase, Anti-M Protein

- **Treatment:** Clinical cases/ healthy Carrier.. Penicillin G/V.. Monthly injection for children.. cotrimoxazole

- Group A is still highly susceptible to Penicillin.. Less to Cephalosporins & Macrolides and other antibiotics

- No Vaccine is available
Corynebacterium diphtheriae, C. ulcerans

- Sore Throat.. Not invasive.. Intensive inflammation pharyngeal mucosa, Gray Pseudomembranous.. Release Diphtheria exotoxin.
- Clinical Features: Myocarditis.. Peripheral nervous system/ Neuritis, Adrenal glands.. Laryngeal obstruction.. Respiratory & Heart Failure, Death
- Permanent Immunity by Vaccination.. Rapid diagnosis .. antibiotic treatment + Diphtheria Antitoxin
- Lab Diagnosis: Throat swab .. Direct Smear not significant, Culture for C. diphtheria.. selective Tellurite Blood agar ..Toxin test..Not all strains are toxigenic.
- Vincet Angina / Trench Mouth : Mixed infection.. Oral Normal flora.. Borrelia / Treponema vincenti/ Fusobacterium.. Oral mucosa Lesions/ Gingivitis.. gum swelling (gingivitis)
Gingivitis