

Bacterial Respiratory Infection (3rd Year Medicine)

Prof. Dr. Asem Shehabi

Faculty of Medicine

University of Jordan

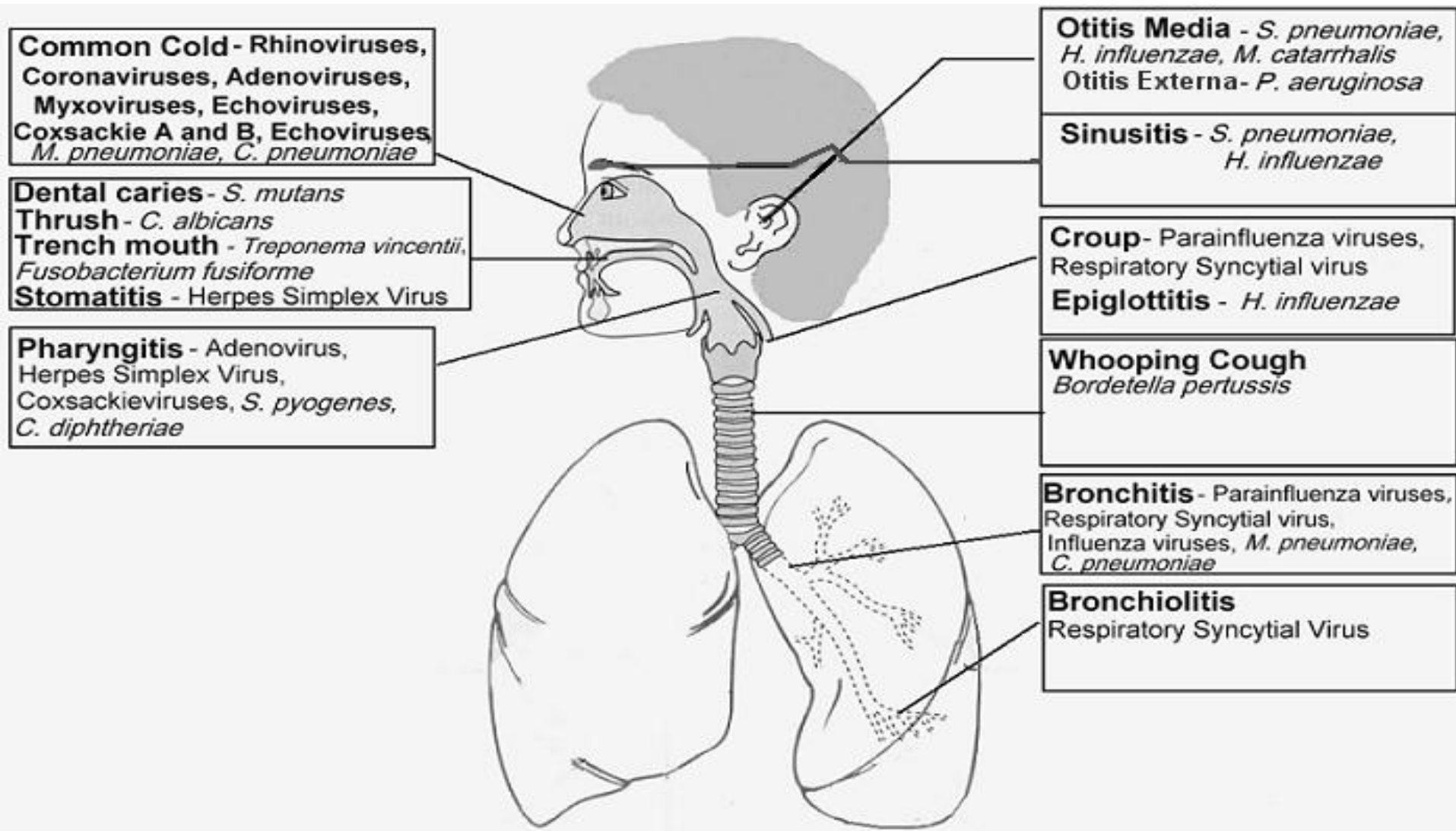
Introduction

- 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.**

- 2/
- 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

Fig.1 Upper Respiratory Tract Infection

Most infections are mixed Viruses plus Bacteria



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.

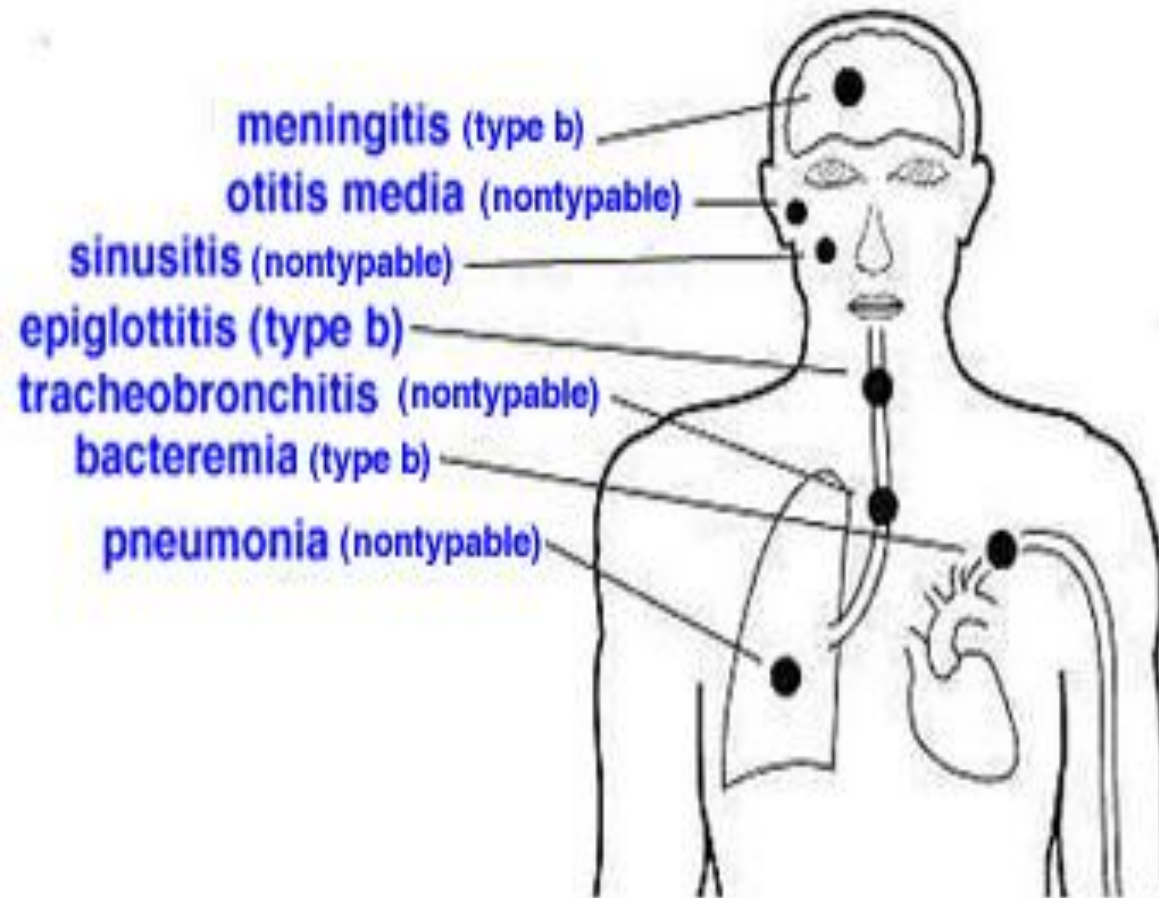
Common Bacteria Agents cause of Upper Respiratory Infections

- ***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



Streptococcus 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 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

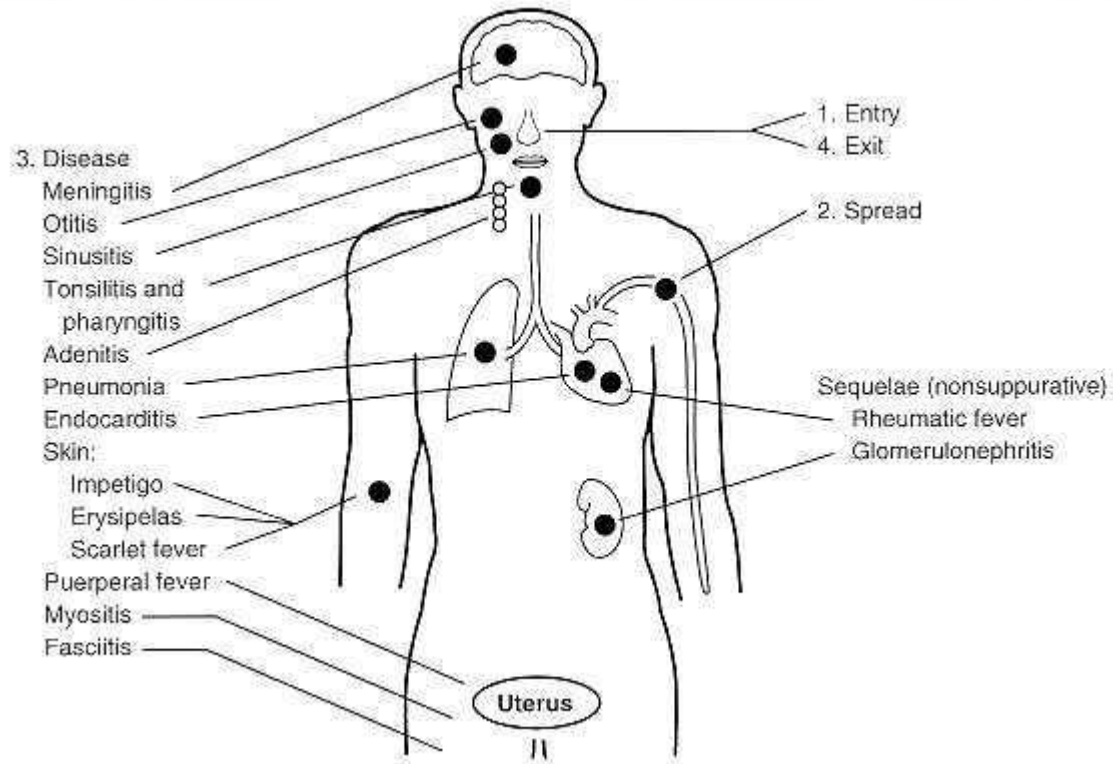
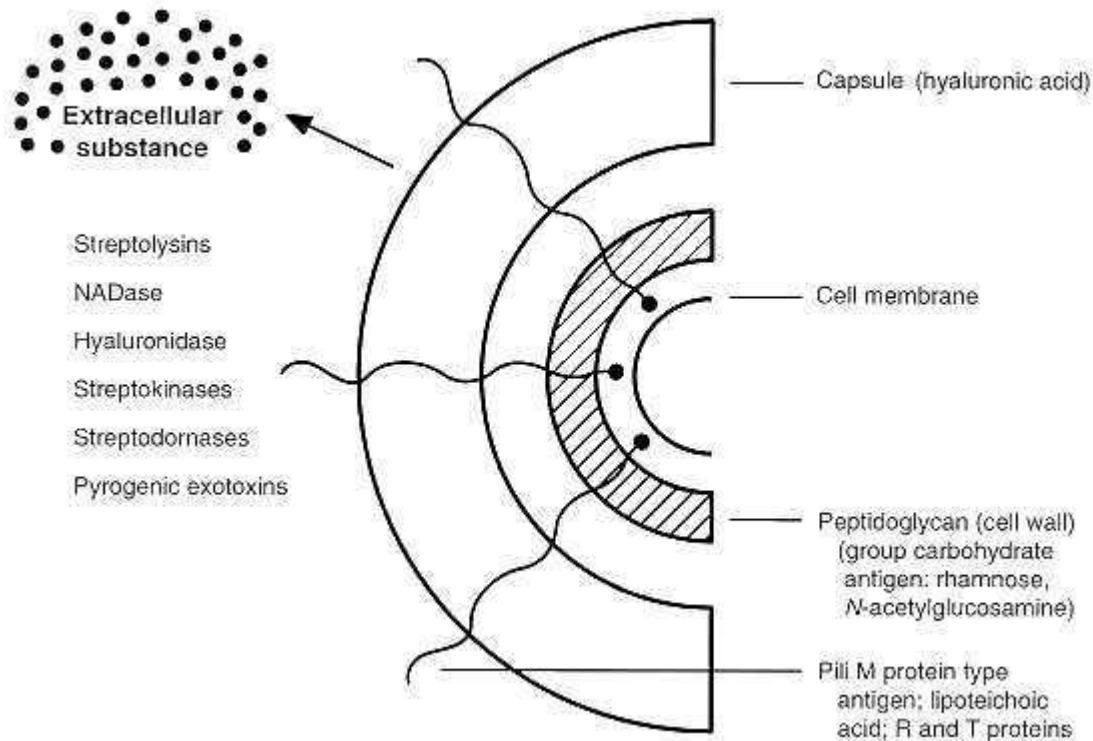


Fig.5- Streptococcus pyogenes



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 Bacteremia, 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 ..Autoimmunological 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 O (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. diphtheriae*.. 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)

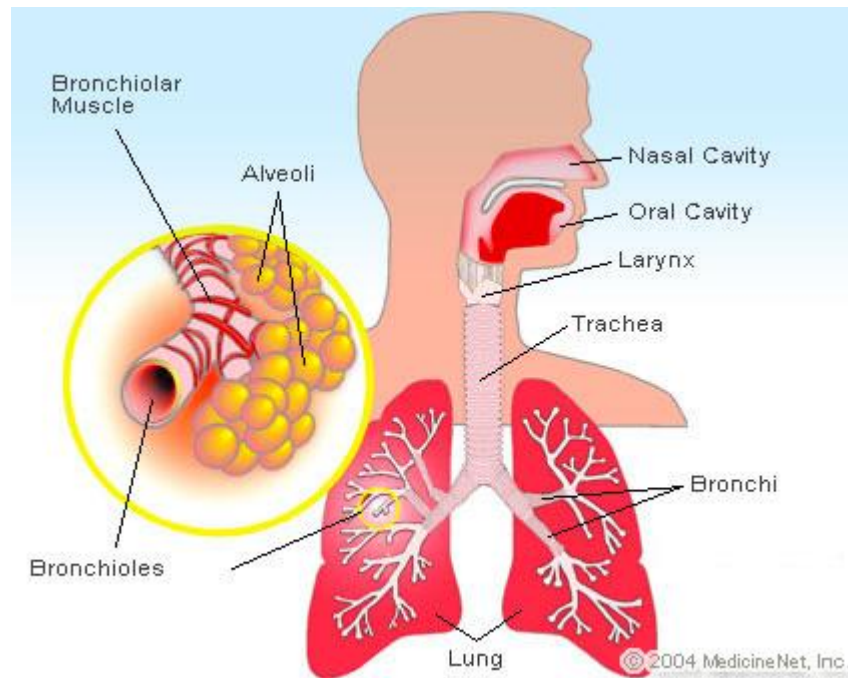
Gingivitis



Lower Bacterial Respiratory Infection

- Mostly endogenous source of Infection.. **Opportunistic organisms** spread directly from the upper respiratory tract to the lung...rarely through blood.
- A combination of factors ..including virulence of infecting organism, **status of the local defenses**, and overall health of the patient may lead to bacterial pneumonia.
- The patient become more susceptible to infection by presence **Chronic obstructive lung disease** (COPD), Followed Viral Respiratory infection.. Infant ,Old age, dysfunction of immune defense mechanisms..

Lung Infections



Acute/Chronic bronchitis

- A clinical syndrome caused by inflammation trachea, swelling & irritation bronchi & bronchioles.. Persistent dry cough.. Few sputum.. often associated with viral respiratory tract infection.
- **Acute bronchitis** in children is rarely a primary bacterial infection.. mostly viral agents.
- **Adults Acute & Chronic bronchitis** followed viral infections/directly associated with *Strept. pneumoniae, H. influenzae, Group A Strept., S. aureus*.. Complications: Asthma.

Whooping cough & Bronchitis

Bordetella pertussis* / *B. parapertussis: Release **Endotoxin, Cytotoxins**.. Attachment & Obstruction ciliated epithelium cells of small Bronchi..

- **Clinical Features:** **1-Catarrhal stage**..Mild Cough, & inflammation pharynx-Larynx, Low fever.. **Bronchitis**
- **2-Paroxysmal cough**.. Prolonged irritating Cough & mucus secretion, Fever, Cyanosis, Lung collapse, Convulsions, No Blood invasion.. Most infection Young children.. Rare Adults..Community Outbreaks & single cases.
- **Clinical Diagnosis** & Laboratory test by PCR for detection bacterial DNA in nasopharyngeal swab.. Specific antibodies blood & Urine.

Pneumonia

- **Pneumonia** is a common illness that affects millions of people each year worldwide.. Associated with high fatality.
- The symptoms of pneumonia range **mild -severe-fatal**. The severity depends on the type of organism, Patient's Age, Health condition & general immunity.
- **Mild Pneumonia**.. inflammation of the lungs - Fever – few Sputum.. caused by many different opportunistic organisms .. **Bacteria & Viruses** (single or mixed)
- **Severe pneumonia**: Bacterial Lung Inflammation, fluid buildup, Purulent sputum.. containing pus / blood.. High Fever, Malaise, Nausea, Vomiting, Breath shortness Increased heart beats, Mental confusion..few % blood sepsis.

Bacterial Causes of Pneumonia

- Pneumonia categorized into **community-acquired pneumonia** (CAP), or **Hospital-acquired pneumonia** (HAP)/often in ICU followed Intubation & use ventilator..

Health care-acquired pneumonia

- **CAP** .. mostly *Strep. pneumoniae* .. followed viral infection in children & elderly patients

- **HAP**.. Gram-ve *P. aeruginosa*, *Klebsiella pneumonia*, *Acinetobacter baumannii* ..Less by *Haemophilus influenzae type b*, *S. aureus* or others.. May be associated with blood sepsis.

- Both produce similar clinical features.. Fatal without antibiotic & Supportive respiratory treatment.

Streptococcus pneumoniae

- **90 Capsular Serotypes**: Common Healthy Carriers.. normally found in the nasopharynx of **5-10% of healthy adults.. 20-40% of healthy children**
- **Several virulence factors**: Polysaccharide capsule & Pneumolysins (invasion), Both resist phagocytosis & host's immune system.. Released Proteases damages mucosa IgA ..overcome host defense.
- ***S.pneumoniae*** starts as **intrapulmonary abscess**.. Lung necrosis.. can be associated with **Empyema** (Pus, fluid & bacterial cells accumulate in the pleural cavity). . Often more associated with Blood sepsis, Meningitis, Sinusitis, Otitis Media in young children than adults.

Strept. pneumoniae & Viridans Streptococci Group



Lab Dignosis

- ***S. pneumoniae*** can be differentiated from *S.viridans*, which is also alpha hemolytic on Blood agar.. **Optochin / bile solubility test**..Gram-positive diplococci
- About 80% *S. pneumoniae* are R-Penicillin in Jordan & other Arab countries.
- Treatment: Amoxicillin-clavulanate, Macrolides (Azithromycin, clarithromycin), Fluoroquinolones (Levofloxacin, ciprofloxacin).. For Bacteremia +meningitis..vancomycin, ceftriaxone/cefotaxime
- **Prevention:** (Pneumovax) Polysaccharide vaccine.. **23-valent strains**.. For adults. A **13-valent strains vaccine / Prevnar** ..3 doses for children.. Up 2-year.. Both resulted in high protection.

Atypical Pneumonia

- Atypical pneumonia caused by *Mycoplasma*, *Chlamydia*, *Legionella*.. These related to Gram-ve bacteria.. Have few amount LPS.. Attached to respiratory mucosa..Not common part of Respiratory flora..**Opportunistic pathogens**
- Causing mostly milder forms of pneumonia.. characterized by slow development of symptoms..dry cough & mild fever unlike other forms of pneumonia
- ***M. pneumoniae*** : The smallest size Bacteria ..Lack true Cell wall.. **Lipid bi-layer membrane**.. Aerobic Growth, Respiratory Mucosa.. Other *Mycoplasma* spp. cause other human diseases.. Also in Animals, Birds

Mycoplasma

- *M. pneumoniae* ..spread by droplet infection.. often develop Low fever & dry cough symptoms ..few days-weeks.. anemia, rashes, neurological syndromes.
- **Acute/ Subacute Pharyngitis.. Bronchitis..** Common Infection in Fall-Winter.. Mostly Old children & Jung Adults.
- Severe forms of *M. pneumoniae* have been described in all age groups.
- Lab Diagnosis: Special culture medium.. PCR.. Sputum, Pleural fluid, Blood.
- **Serological Cold-Agglutination Test**.. Increased antibody titers. **Treatment**: levofloxacin, moxifloxacin, Macrolides/ Azithromycin.. No Vaccine

Chlamydia species

- **Chlamydia**.. Species cause human Respiratory/ both genital tract diseases or both.. Obligate intracellular.. Causing intracytoplasmic inclusions..Rapidly killed outside body.. Dryness, High temperature.
- **Live cycle:** Infectious elementary bodies attached to mucosa and promoting its entry..
- Reticulate bodies developed as inclusion bodies in cytoplasm phagosomes & released new **Infectious elementary bodies**
- 1- **Chlamydia trachomatis** Common cause of sexually transmitted disease (STD) **Nonspecific urethritis** .. transmitted from mother to newborn babies..maternal fluid.. causes severe pneumonia & Eye infection..Conjunctivitis & Trachoma.
-

Chlamydial Pneumonia

- 2- *C. pneumoniae*:** Related only to RST ..droplets infection..Infants/children often develops gradually.. several weeks mild respiratory symptoms, dry irritating prolonged cough..nasal congestion.. with/without fever..Few weeks..No blood sepsis.
- Infection in adults often asymptomatic, mild, May include sore throat, headache, fever, dry cough.
 - Clusters of infection have been reported more common in Children than Adults.
 - **Diagnosis & treatment:** Sputum, throat-nasal swabs, MaCoy Cell Culture, ELISA Specific antibodies, PCR.
 - Treatment: Macrolides, Tetracyclines, levofloxacin, moxifloxacin .. No Vaccine

Legionella pneumophila

- **Legionella:** Carry flagella, Pathogenic/ Nonpathogenic spp. often found in **natural aquatic bodies and wet soil**. Facultative Anaerobes Growth in Cold/Hot (4- 80C) Water..Transmitted, Inhalation water drops via air condition system.. Wet Soil.. Cause single /outbreak of disease.
- Attached Lung Mucosa..multiply intracellular within the macrophages..High Fever..rarely blood sepsis.
- **Incubation period** 2-10 days .. Nonproductive / Productive dry cough.. Shortness of breath, Chest pain, Muscle aches, Joint pain, Diarrhea, Renal Failure.

L. pneumonphila-2

- **Risk factors** include heavy cigarette smoking, old age underlying diseases such as **renal failure, cancer, diabetes..** chronic obstructive pulmonary, suppressed immune systems, corticosteroid therapy.
- **Diagnosis & treatment:** Special culture media, blood/urine specimen for detection Specific antibodies or Antigens by PCR, or EISA .. Macrolides (azithromycin), levofloxacin, moxifloxacin .. No Vaccine.