Microbiology - RS

Activities as Slides

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Lecture 1:
Respiratory Microbiome & Host Defenses

Microbial Density and Composition[1]

- The oropharynx contains a higher microbial density than the nasal cavity.
- **Oxygen tension** (P_{O2}) is a key factor in shaping respiratory microbial communities.

  For example, the dominance of *Prevotella* in the oropharynx is driven by reduced oxygen tension compared to the nasal cavity.
- The lungs are **not** sterile; they contain microbial communities, and it is false to say they lack nutrients for growth.

Microbial Density and Composition(2)

- *Staphylococcus epidermidis* is a dominant colonizer of the nasal cavity.
  - It produces a **serine protease** that inhibits *Staphylococcus aureus* colonization there.
- However, *S. epidermidis* **rarely** persists in the **lower respiratory tract**.

✓ The LRT does **not** contain an abundant or consistent microbial population compared to the upper tract.

- The **mode of birth** is one of many factors (e.g. host and environmental factors) that influence the respiratory microbiota.
  - Early-life microbial exposure is associated with long-term respiratory infection susceptibility through modulating adaptive mucosal immunity.

Host Defenses

1. **Mechanical Defenses:**
   - *Turbinate-induced turbulent airflow* is a major mechanical defense, increasing the deposition of microbes onto mucus-coated surfaces.
2. **Chemical Defenses**:
   - **Lysozyme**: Hydrolyzes Gram-positive bacteria.
   - **Surfactant**: Proteins A and D opsonize bacteria, which enhances **phagocytosis**.
   - **Mucosal IgA**: Preferred in the Upper Respiratory Tract (URT) because it neutralizes pathogens without triggering complement-mediated inflammation.
3. **Immune Cells:**
   - Th1 cells are **not** the essential cells for clearing ***extracellular*** pathogens (this usually involves Th17 or antibody-mediated responses).

✓*Corynebacterium diphtheriae* does **not** release free fatty acids to protect the URT (this is a trait associated with other skin/mucosal flora like *Cutibacterium*).

Pathology and Risk Factors[1]

- **Aspiration Pneumonia:**
  - This results from altered host reflexes rather than increased bacterial virulence.
  - It is **not** simply the invasion of environmental bacteria via inhalation.
- **Ventilator-Associated Pneumonia (VAP):**
  - Occurs because intubation bypasses multiple innate mechanical defenses.
  - Bacteria also form biofilms on endotracheal tubes.

Pathology and Risk Factors(2)

- **Impact of Antibiotics:**

  Antibiotics do **not** reduce infection risk simply by eliminating pathogens; they often disrupt the protective microbiota, potentially increasing susceptibility.

- **Impact of Corticosteroids:**

  These increase the risk of respiratory infection by suppressing the activation of innate immune cells.

- **Impact of Vaccination:**

  Vaccines do not change microbiota composition *exclusively* by preventing inflammation; they have broader effects on colonization.

✓ **Diagnostic Note:**

Detecting bacteria in a bronchoalveolar lavage (BAL) does **not** automatically mean an infection exists (it could represent colonization or contamination).

Lecture 2:
Pneumococcus, Haemophilus, & Moraxella

Streptococcus pneumoniae (Pneumococcus)

- Differences in virulence among serotypes are **dependent on the capsule.**
- Autolysin is not a virulence factor for Streptococcus pneumoniae that act to evade neutralization by the mucosal IgA.
- **Mechanism of Infection:**
  - Pneumococcal disease usually starts with colonization of the upper airways, **not** direct inhalation into the alveoli.
  - Pneumonia is frequently caused by endogenous pneumococci already colonizing the patient's URT.

Pneumococcal community-acquired pneumonia is most frequently caused by endogenous pneumococci that already colonized the patient upper respiratory tract.
TRUE

- **Host Defense:**
  - The spleen is critical for defending against pneumococcal bacteremia.

Streptococcus pneumoniae (Pneumococcus)

Features

- **Identification:**

  Viridans streptococci are **resistant to optochin** and **not bile soluble**, distinguishing them from Pneumococci (which are sensitive and soluble).

❖ **Clinical Features:**

- **Pneumonia:** Classical features include abrupt fever, chest pain, rusty sputum, and lobar consolidation on X-ray.
- **Sinusitis:** Features include severe headache, stuffy/runny nose, and post-nasal drip.

Streptococcus pneumoniae (Pneumococcus)
Diagnosis and Vaccination

- **Diagnosis:** Urinary antigen tests can diagnose pneumococcal pneumonia.

- **Vaccines:**
  - Vaccination does **not** protect against *all* capsular serotypes (only those in the vaccine).
  - Pneumococcal conjugate vaccines **do not provide complete herd immunity for all types.**

Haemophilus influenzae

- A **Gram-negative,** not Gram-positive, coccobacillus.
- Pleomorphic, and fastidious as it requires hemin and NAD factors and grows on chocolate agar, not on plain blood agar
- **Non-typeable H. influenzae (NTHi):**
  - These are **unencapsulated** strains (not encapsulated).
  - They normally colonize the respiratory tract and cause mucosal infections like otitis, sinusitis, and COPD exacerbations.

❖ **Vaccine:**

- The Hib vaccine protects against serious infections (meningitis, epiglottitis) caused specifically by ***Haemophilus influenzae*** **type b** (encapsulated).
- There are no licensed vaccines for **NTHi** or ***Moraxella catarrhalis***.

Moraxella catarrhalis

- **Gram-negative** bacteria (not Gram-positive).
- Oxidase-positive, DNase-positive, bacteria that normally colonizes the respiratory tract but causes frequent mucosal infections such as otitis, sinusitis, and COPD exacerbations.
- **Resistance**: Approximately 90% of clinical isolates produce beta-lactamase, which significantly impacts therapy choices.
- No licensed vaccine!

Community-Acquired Pneumonia (CAP)
Management

- **Diagnostics**:
  Multiplex PCR can be used to identify the cause of CAP.
- **Treatment Decisions:**
  - Management is **not** always based on high-dose amoxicillin alone.
  - It relies on interpreting **Minimal Inhibitory Concentration** (MIC), **local epidemiology of causative strains of bacteria**, and **patient factors** (allergy, severity, comorbidities).

Vaccination against Streptococcus pneumoniae, Haemophilus influenzae, and Moraxella catarrhalis are licensed to protect from encapsulated strains only. **FALSE**

Lecture 3:
HAP, VAP, and Resistant Pathogens

Gram-Negative Pathogens

Acinetobacter species

- A major cause of Hospital-Acquired (**HAP**) and Ventilator-Associated Pneumonia (**VAP**).
- Its ability to **survive on dry surfaces** directly contributes, independent of patient-to-patient contact, to hospital and ICU outbreaks.
- Biofilm formation on endotracheal tubes is a reason VAP often relapses despite treatment.

✓ **Identification:**

It is **oxidase-negative** (not positive) and **non-fermenter**.

Gram-Negative Pathogens

Klebsiella pneumoniae:

- **Alcoholism** increases aspiration risk, predisposing patients to Klebsiella pneumonia.
- Associated with **lung abscesses** that often require longer treatment than anaerobic abscesses.
- It can **cause empyema**, a serious lung infection where pus collects in the pleural space, complicating pneumonia, particularly in diabetics or immunocompromised people.

❖ **Imaging**:

Bulging interlobar fissures are suggestive but **not pathognomonic** (meaning exclusive/definitive) for Klebsiella.

❖ **Treatment:**

- **ESBL strains**: The treatment of choice is **Imipenem** (a carbapenem), **not** third-generation cephalosporins.

❖**Control**:

Environmental disinfection plays a large role in controlling transmission.

Gram-Negative Pathogens

Stenotrophomonas maltophilia:

- The first-line drug of choice is **Cotrimoxazole**.
- It is an **oxidase-negative** organism (often confused with oxidase-positive organisms).

Gram-Negative Pathogens
Identification Rule of Thumb:

- **Oxidase-positive** non-fermenters suggest *Pseudomonas aeruginosa* or *Burkholderia*.

  (The activity listed this relationship as False when linked to Acinetobacter/Steno, and False when linked to oxidase-negative) .

- *Acinetobacter* and *Stenotrophomonas* are **Oxidase-negative**.

Gram-Negative Pathogens
MDR Treatment:

- **Colistin** is not typically the **preferred first-line therapy** for MDR **Gram-negative** pneumonia (usually reserved for last-line due to toxicity).

Gram-Positive Pathogens

Staphylococcus aureus

1. **MRSA (Methicillin-Resistant S. aureus):**
   - **Treatment:**
     Can be treated with **Vancomycin or Linezolid.**
   - **Resistance:**
     MRSA **cannot** be treated with Cefazolin (a cephalosporin).
   - **Complications:**
     In MRSA bacteremia with empyema, antibiotics alone are **not** sufficient (drainage is usually required), even if blood cultures clear rapidly.
   - **Post-Influenza:**
     In progressive pneumonia with leukopenia, Clindamycin monotherapy is **not** sufficient even if it suppresses toxins (requires bactericidal activity).

Gram-Positive Pathogens

Staphylococcus aureus

2. MSSA (Methicillin-Sensitive S. aureus):

- Can be treated with Linezolid (though not usually first-line).

❖ Virulence Factors (of Staph. aureus):

a. PVL (Panton-Valentine Leukocidin):
Strongly linked to necrotizing pneumonia with abscess formation.

b. Staphyloxanthin:
Enhances survival inside neutrophils by neutralizing oxidative bursts.

❖ Identification:

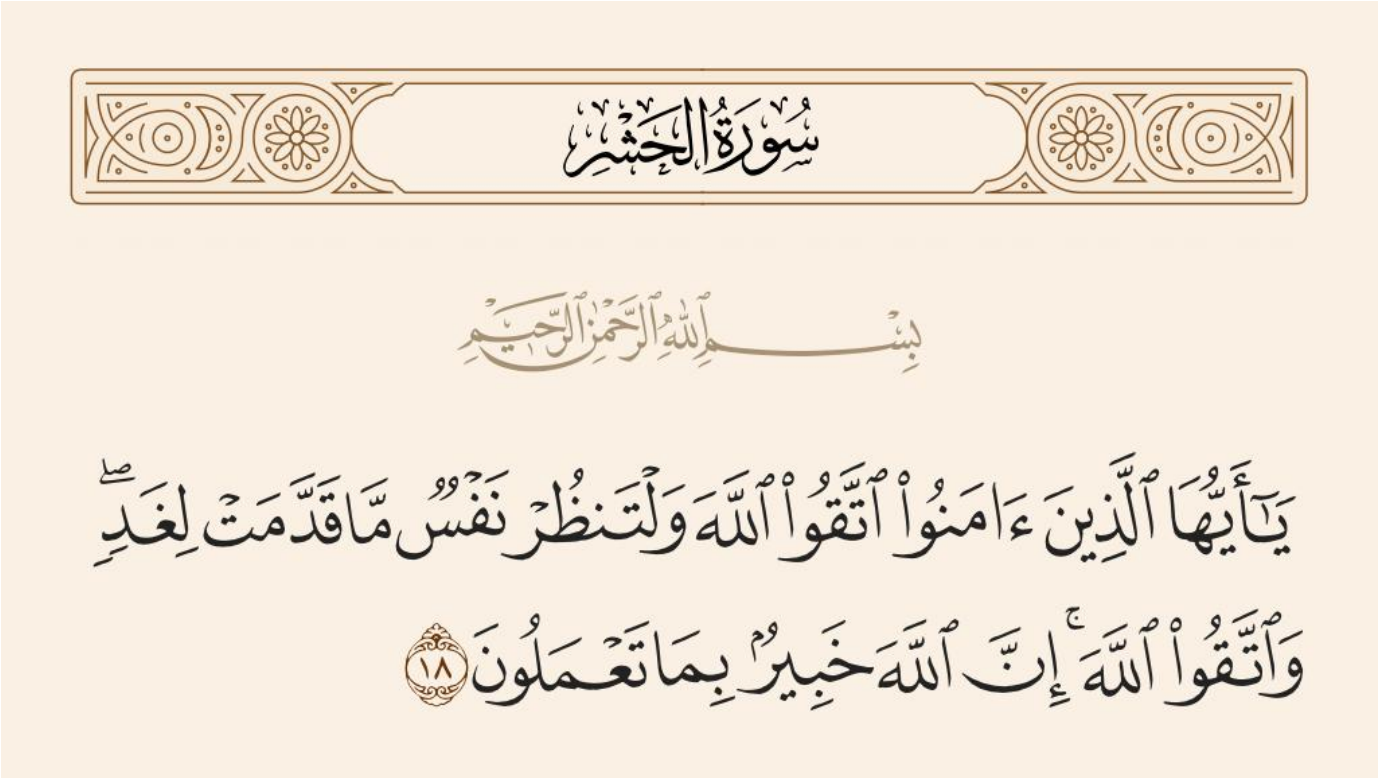
The presence of golden-yellow beta-hemolytic colonies does **not** reliably distinguish *S. aureus* from all other Gram-positive cocci (**coagulase test is definitive**).

❖ Control:

Contact precautions are critical for MRSA control.

The End

- Activity 1
- Activity 2
- Activity 3



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