

Nosocomial Pneumonia

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Burden of Hospital-Acquired Pneumonia

- Second most common nosocomial infection in the U.S.
 - ✓ 5-10 episodes per 1000 admissions
 - ✓ 25% of all intensive care unit infections
- Attributable mortality rate: 33-55%
- Increases hospital length of stay 7-9 days
- Increases hospital cost by \$40,000

Definition of Nosocomial Pneumonia

- Pneumonia that develops in a patient hospitalized ≥ 48 hours
- Also known as hospital-acquired pneumonia (HAP)
- Ventilator-associated pneumonia (VAP)
 - ✓ Pneumonia that develops ≥ 48 hours after endotracheal intubation

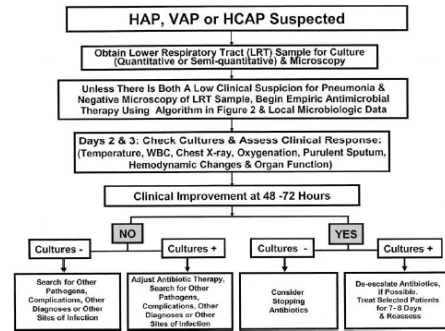
<5 Days: Non-Multidrug-Resistant Bacteria

- *Streptococcus pneumoniae*
- *Moraxella catarrhalis*
- *Haemophilus influenzae*
- Anaerobes
- *Legionella pneumophila*
- Gram-negative rods, not extended-spectrum β -lactamase (ESBL) producers

≥5 Days: Multidrug-Resistant Bacteria

- Methicillin-resistant *Staphylococcus aureus*
- *Pseudomonas aeruginosa*
- *Acinetobacter* species
- Gram-negative rods, ESBL producers
- Gram-negative rods, carbapenemase producers

Diagnosis



ATS/IDSA

Hospital-Acquired Pneumonia with Viral and Fungal Pathogens Uncommon

Viral pathogens

- Influenza
- Parainfluenza
- Respiratory syncytial virus
- Adenovirus
- Novel influenza A (H1N1) virus was the dominant circulating influenza virus in 2009

Fungal pathogens

- *Candida* spp.
- *Aspergillus fumigatus*

HAP

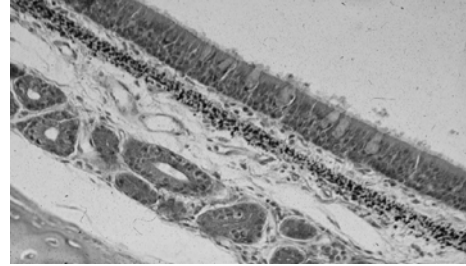
- New radiographic infiltrate after 48 hours of hospitalization.
- Clinical findings suggestive of infection (including new fever, leukocytosis, purulent sputum, and decline in oxygenation).

HAP

- Requires entry of microbial pathogens into the lower respiratory tract.

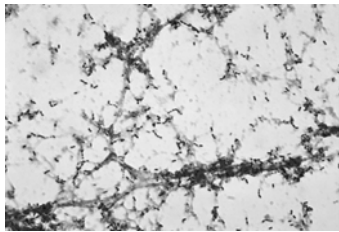
Defense

- 80% of cells in central airways Ciliated, pseudostratified, columnar epithelium.



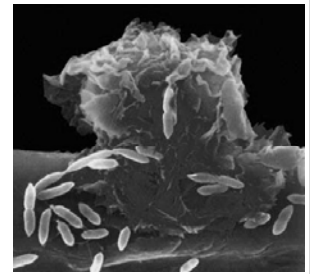
Defense

- Upper Airway
 - ✓ Sneezing
 - ✓ Swallowing
 - ✓ Expectoration



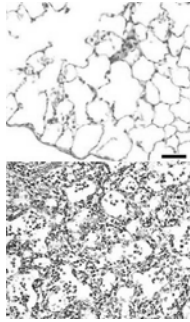
Defense

- Alveoli
 - ✓ Alveolar Macrophages (phagocytes)
 - ✓ Lining fluid: surfactant, fibronectin, immunoglobulins which can opsonize or lyse microbial pathogens.



Pathophysiology

- Inflammatory Exudate
- ✓ Pulmonary Consolidation
- ✓ Systemic Manifestations
 - Fever
 - Chills
 - Myalgias
 - Malaise



Transmission

- Hematogenous
 - ✓ Extrapulmonary Sites
 - Endocarditis
 - Vascular Catheter infections
 - Retropharyngeal infections
- Direct Inoculation/Contiguous Spread
 - ✓ Tracheal intubation
 - ✓ Penetration of the chest wall

Transmission

- Aspiration
 - ✓ Level of consciousness (alcohol, drugs)
 - ✓ Neurologic Dysfunction (seizure, stroke)
 - ✓ Mechanical Impairments (endotracheal tube, nasogastric tube)
- Inhalation
 - ✓ Particles > 10 μ m get deposited in nose and oropharynx
 - ✓ 5-10 μ m Central airways
 - ✓ <5 μ m can make it all the way to alveoli

HAP

- Requires entry of microbial pathogens into the lower respiratory tract.
 - ✓ Aspiration of oropharyngeal pathogens
 - ✓ Leakage of bacteria around an endotracheal tube
 - ✓ Less common: Direct inhalation, Hematogenous spread, Translocation from the GI tract.

Physical Exam

- Fever
- Purulent Sputum
- Signs of pulmonary consolidation
 - ✓ Dullness
 - ✓ Increased fremitus
 - ✓ Egophony
 - ✓ Bronchial breath sounds
 - ✓ Rales

Diagnosis: Sample Analysis

- Sputum
 - ✓ Gram's staining
 - ✓ Culture
- Fiberoptic Bronchoscopy
 - ✓ Bronchoalveolar lavage (BAL)
 - ✓ Protected Sheath Brush
 - ✓ Transbronchial Biopsy
- Thoracentesis
 - ✓ Consider if significant pleural effusion
- Open-Lung Biopsy



Diagnosis: Chest Radiography

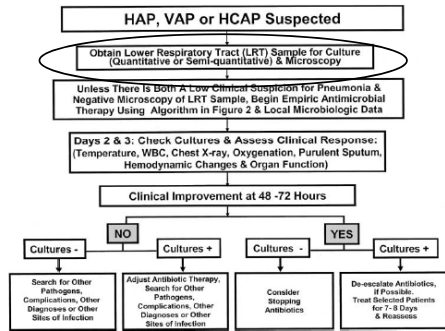
- Confirm the presence and location of an infiltrate
- Assess the extent of infection
- Detect pleural involvement
- Gauge hilar lymphadenopathy
- Monitor response to therapy



HAP

- Invasive Diagnostic Strategy vs Clinical Diagnosis?

Algorithm



ATS/IDSA

Endotracheal Aspirate

- **Blind tracheobronchial aspiration**
 - ✓ Insertion of a flexible catheter into the distal trachea
- **Bronchoscopically guided**
 - ✓ BAL (Bronchoalveolar Lavage)
 - ✓ Protected Specimen Brush

HAP

- **Invasive Diagnostic strategy vs Clinical Diagnosis?**
 - ✓ Lower respiratory culture should be obtained
 - Bronchoscopically
 - Non-bronchoscopically
- **Bronchoscopic strategy may improve outcomes – one study showed improved 14 day mortality**

Selecting Antimicrobial Regimens

- **Choosing an empiric regimen**
- **Choosing a specific regimen**

Keys to Empiric Regimen Selection

- Empiric therapy should be broad enough to cover all suspected pathogens.
- Optimal dosing is needed to control infection.

Empiric Regimens: At Risk for MDR Infection

A.	B.	C.
MRSA coverage	antipseudomonal cephalosporin	aminoglycoside
	antipseudomonal carbapenem	antipseudomonal fluoroquinolone
	β -lactamase inhibitor	

Am J Respir Crit Care Med 2005;171:388-416.

Empiric Regimens: Not at Risk for MDR Infection

1. Ceftriaxone
2. Fluoroquinolone
3. Ampicillin/sulbactam
4. Ertapenem

+/- Azithromycin

Specific Infection → Specific Regimen

- Reassess empiric regimen after 48 hours
- Goal: de-escalate or streamline antimicrobial coverage
- Base on microbiologic data and clinical response
- Improves patient outcome by minimizing complications caused by broad-spectrum coverage
 - ✓ *C. difficile* infection
 - ✓ Selection of MDR pathogens

Limit Duration

7 days

- Uncomplicated HAP or VAP, and
- Responding to therapy

14 days

- *P. aeruginosa*
- *Acinetobacter* species
- Not responding to therapy

Prolonged therapy leads to colonization with resistant organisms.

Prevention Measures: Aspiration Precautions

- Monitor sedation
- Elevate head of bed
- Consider speech and swallow consult

Assess Nonresponders

- Wrong diagnosis (not pneumonia)
- Wrong antimicrobial
 - ✓ Wrong organism or drug-resistant organism
 - ✓ Suboptimal dosing
- Complication
 - ✓ *C. difficile*
 - ✓ Empyema or abscess
 - ✓ Drug fever

Prevention Measures: Vaccination

- Assess vaccination status prior to discharge
 - ✓ Pneumococcal vaccine
 - ✓ Influenza vaccine
- These vaccines may be given together
- *S. pneumoniae* is a leading cause of vaccine-preventable illness and death in the U.S.
 - ✓ Approximately 70 million people with existing indications for vaccination are not vaccinated

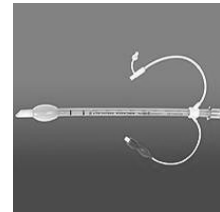
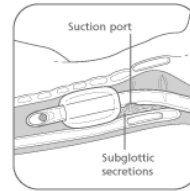
NHIS, 2007

Prevention Measures: Infection Control

- Hand hygiene to reduce spread of multidrug-resistant pathogens
- Transmission-based precautions
 - ✓ Contact
 - ✓ Droplet
 - ✓ Airborne

VAP – ET tube

- Endotracheal tube
 - ✓ Cuff pressure 20 cm H₂O
 - ✓ Aspiration of subglottic secretions may help prevent early VAP



Prevention of VAP

- Intubation and Mechanical Ventilation increase the risk of pneumonia 6 to 21 fold in prospective studies.

VAP – GI considerations

- Oral antiseptics – positive results in cardiothoracic surgery patients
- Selective Decontamination of the Digestive tract – Mixed results
- Antacids, H₂ blockers, Proton Pump inhibitors – Mixed results, increased enteric gram negative colonization
- Probiotics - jury still out

VAP – GI considerations

- Early enteral feeding may increase incidence
- Post pyloric feeding may reduce incidence based on a metaanalysis

VAP – Vent Considerations

- Minimize duration of mechanical ventilation
 - ✓ Sedation protocols
 - ✓ Weaning protocols
- Re-intubation increases risk
- Ventilator Bundles
 - Educational materials, guidelines, checklists, protocols

VAP – Vent Considerations

- Frequent circuit changes do not help
- Humidifiers and heat-moisture exchangers do not impact incidence
- Use of Orotracheal tubes and orogastric tubes, rather than nasotracheal and nasogastric can reduce Nosocomial sinusitis (potential bacterial reservoir)

VAP - Considerations

- Semi-recumbent position is better than supine – Head of Bed >30-45 degrees
- Early tracheostomy – some positive data, but yet to be applied to a broad ICU population