Healthcare-associated Pneumonia in the Elderly: Difficulties in Radiologic Assessment

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Respiratory Tract Infection

• **Upper** respiratory tract infection:
  - Sinusitis, Tonsillitis,
  - Pharyngitis, Laryngitis,

• **Lower** respiratory tract infection:
  - Tracheobronchitis,
  - Bronchiolitis,
  - **Pneumonia**

![Diagram of respiratory tract with labeled parts: Upper respiratory tract (Nasal cavity, Pharynx, Larynx) and Lower respiratory tract (Trachea, Bronchus, Lung).]
Classification of Pneumonia

♠ Community-acquired pneumonia (CAP), Hospital-acquired pneumonia (HAP), Ventilator-associated pneumonia (VAP), Healthcare-associated pneumonia (HCAP)

◆ Pneumonia in normal host, Pneumonia in AIDS patients, Pneumonia in non-AIDS immune compromised host

➢ Acute vs Chronic, Typical vs Atypical pneumonia

● Bacteria, Mycoplasma, Mycobacteria, Virus, Rickettsia, Protozoa, Parasite, Fungi, Mixed pneumonia

★ Lobar pneumonia, Bronchopneumonia, Interstitial pneumonia
<table>
<thead>
<tr>
<th>CAP</th>
<th>Pneumonia acquired in the community or within 48 hours of admission to a hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAP</td>
<td>Pneumonia that occurs 48 hours or more after admission, which was not incubating at the time of admission</td>
</tr>
<tr>
<td>VAP</td>
<td>Pneumonia that arises more than 48–72 hours after endotracheal intubation</td>
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<tr>
<td>HCAP</td>
<td><em>Pneumonia in any patient with one of the following features</em></td>
</tr>
<tr>
<td></td>
<td>✓ Hospitalized in an acute care hospital for 2 or more days within 90 days of the infection</td>
</tr>
<tr>
<td></td>
<td>✓ Resided in a nursing home or long-term care facility</td>
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<td></td>
<td>✓ Received recent intravenous antibiotic therapy, chemotherapy, or wound care within the past 30 days of the current infection</td>
</tr>
<tr>
<td></td>
<td>✓ Attended a hospital or hemodialysis clinic</td>
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</tbody>
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ATS and IDSA, Am J Respir Crit Care Med 2005;171:388
Healthcare-associated Pneumonia

✓ A distinct clinical entity
✓ Between CAP and HAP
✓ Increased risk in the elderly

Increased elderly populations receiving health care outside the hospital setting, including home wound care, infusion therapy, dialysis, nursing homes, and similar settings → One of the most frequent causes of hospitalization and mortality in these patients is pneumonia.
Pathogens in HCAP

- A wide spectrum of bacterial pathogens, may be *polymicrobial*
- Viral or fungal pathogens, rare in immunocompetent hosts
- *Multidrug-resistant pathogens*

Comorbidity in HCAP

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>HCAP (n = 182)</th>
<th>CAP (n = 163)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>97 (53.1)</td>
<td>73 (44.7)</td>
<td>0.059</td>
</tr>
<tr>
<td>Male</td>
<td>135 (74.2)</td>
<td>94 (57.7)</td>
<td>0.001</td>
</tr>
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<td>135 (74.2)</td>
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<td>0.001</td>
</tr>
<tr>
<td>Comorbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neoplastic disease</td>
<td>118 (64.8)</td>
<td>34 (20.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronic lung disease</td>
<td>44 (24.2)</td>
<td>32 (19.6)</td>
<td>0.309</td>
</tr>
<tr>
<td>Chronic heart disease</td>
<td>45 (24.7)</td>
<td>45 (27.6)</td>
<td>0.543</td>
</tr>
<tr>
<td>Chronic liver disease</td>
<td>1 (0.5)</td>
<td>4 (2.5)</td>
<td>0.193</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>7 (3.8)</td>
<td>7 (4.3)</td>
<td>0.833</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>10 (5.5)</td>
<td>9 (5.5)</td>
<td>0.991</td>
</tr>
<tr>
<td>Diabetes</td>
<td>34 (18.7)</td>
<td>32 (19.6)</td>
<td>0.823</td>
</tr>
<tr>
<td>Autoimmune disease</td>
<td>2 (1.1)</td>
<td>1 (3.7)</td>
<td>0.156</td>
</tr>
<tr>
<td>Two or more comorbidities</td>
<td>68 (37.4)</td>
<td>37 (22.7)</td>
<td>0.003</td>
</tr>
</tbody>
</table>
# HCAP >> CAP

- Older patient
- More multiple and chronic comorbidities
- Less classic respiratory symptoms, more frequent extrapulmonary manifestations
- Increased risk for drug-resistant pathogens
- More severe disease
- Increased mortality

## Common CAP Pathogens
- Streptococcus pneumoniae
- Haemophilus influenzae
- Mycoplasma pneumoniae
- Chlamydia pneumoniae
- Respiratory viruses
- Legionella species
- Gram-negative bacilli
- MRSA

## Common HCAP Pathogens
- MRSA
- Pseudomonas aeruginosa
- Klebsiella pneumoniae
- Acinetobacter species
- Legionella species

- Microbiologically different

*Semin Respir Crit Care Med 2009;30:3*
Pathogenesis of Pneumonia

Pathogenesis

- Inhalation of airborne pathogens
- **Aspiration of oropharyngeal or gastric flora**
  
  *An important mechanism for development of HCAP*
- Hematogenous spread
- Invasion from infected adjacent structures

Development and severity of pneumonia: balance between **host factors** and **pathogen**
Aspiration-related Lung Diseases

**Aspiration:** Accidental entrance of foreign matter into the lower respiratory tract

- Predominantly airway manifestation: Foreign body aspiration, **Diffuse aspiration bronchiolitis**
- Predominantly lung parenchymal manifestation:
  - Acute diseases: **Aspiration pneumonia**, Aspiration pneumonitis, Near drowning
  - Chronic diseases: Exogenous lipoid pneumonia, Interstitial lung disease

**Pathophysiology:**
Quantity and nature of the aspirated material, chronicity of aspiration, hosts’ defense mechanisms, hosts’ response to the aspirated material → bronchiolitis, pneumonitis, acute pneumonia, organizing pneumonia, abscess formation, and interstitial fibrosis,…
Aspiration pneumonia

Infectious process caused by the aspiration of oropharyngeal secretions colonized by pathogenic bacteria.

Risk factors

- **Dysphagia**: cerebrovascular diseases, Parkinson’s disease, dementia, head and neck cancer,..
- Poor oral hygiene - increased oropharyngeal colonization with pathogens
- Defects in host defenses

- 75% of the hospitalized patients with pneumonia were aged 70 and older
- **80.1% of pneumonia patients aged 70 and older were diagnosed with aspiration pneumonia.**

J Am Geriatr Soc. 2008;56:577
Aspiration pneumonia

Imaging findings:
- *Bronchopneumonia pattern*
- Segmental or lobar airspace consolidation
- Abscess, cavitation
- Parapneumonic effusion, empyema

**Distribution:** gravity dependence
- In supine patients, posterior segments of the upper lobes and superior segments of the lower lobes
- In upright patients, the posterior segments of the lower lobes

65/M, nursing home
Diffuse aspiration bronchiolitis

Chronic bronchiolar inflammation secondary to recurrent occult aspiration
First defined by Matsuse T et al. (Chest 1996;110:1289)

**Imaging findings:**
- Chest radiographs: regional or disseminated small nodules and hyperluency.
- Chest CT: diffuse centrilobular nodules with a tree-in-bud pattern. segmental and subsegmental air trapping

**Distribution:**
- Unilateral or bilateral, regional or diffuse
- Lower lobes, dependent aspects of the lungs

**Associated findings:**
- Esophageal mass, esophageal hiatal hernia, air-fluid level within the esophagus
68/M, Parkinson's disease, home-nursing care
Diagnosis of Pneumonia

Combination of Clinical assessment, Microbiological tests, Radiologic imaging

The presence of infiltrates on chest radiograph: the gold standard for diagnosing pneumonia when clinical and microbiologic features are supportive.
Difficulties in Diagnosis of Pneumonia in the Elderly

- **Clinical presentation**: Frequently *unusual*, Mild respiratory symptoms and frequent extrapulmonary manifestations in the elderly HCAP
- **Microbiological tests**: *Low diagnostic rate*
- **Chest radiographs**: Initially *negative* finding and *nonspecific* findings in the elderly HCAP.

✓ **Biological markers**: may have a greater role in the diagnosis of pneumonia.
Radiologic Assessment of Pneumonia

✓ **Chest radiographs**: Initial diagnostic imaging test, must be acquired in all patients with suspected pneumonia

✓ **Chest CT**: not routinely used, more sensitive and specific than chest radiographs

**Radiologic pattern approach**

Radiologic pattern recognition + Clinical setting such as epidemiology, patient’s immune status, medical history, and laboratory data

**Basic radiologic patterns**

- Airspace pneumonia
  - Nodules
- Bronchopneumonia
  - Cavity
- Interstitial pneumonia
Airspace pneumonia, Streptococcus pneumoniae

Bronchopneumonia, Pseudomonas aeruginosa

Interstitial pneumonia, Mycoplasma pneumoniae
Micronodule, Miliary tuberculosis

Small nodule, Varicella pneumonia

Nodule with GGO halo, Paragonimus westermani

Cavitary nodule, Septic lung, Staphylococcus aureus
Pneumatocele, Staphylococcus aureus
Lung abscess
Necrotizing pneumonia, Klebsiella pneumoniae
Pulmonary gangrene, Aspergillus fumigatus
Invasive aspergillosis
Necrotizing pneumonia, Klebsiella pneumoniae
Pneumatocele, Staphylococcus aureus
Great variations in radiologic pattern of pneumonia

- Same microorganism produces several patterns and radiologic patterns overlap in an individual patient

- *Interpretation of a chest radiograph usually does not give useful clues about the causative pathogen. However, chest radiographs provide useful information about the location, extent of pneumonia, and the presence of pleural effusion.*
Role of Radiologic Imaging

- Detecting pneumonia
- Determining extent and location of pneumonia
- Detecting complications
- Differentiating infection from noninfectious disease
- Evaluating underlying predisposing conditions
- Monitoring the radiologic progression and resolution
- Predicting infecting microorganism
Difficulties in Radiologic Assessment of Elderly HCAP

✓ Chest radiographs must be acquired initially in patients with suspected pneumonia. However, **negative chest radiographs do not exclude pneumonia** in patients with suspected HCAP.

✓ Problems to depict current pneumonia due to **multiple comorbidities**
Detection failure of chest radiography

Methods: We analyzed 208 NHCAP cases and compared them based on four groups defined using NHCAP criteria, patients who were: Group A) resident in an extended care facility or nursing home; Group B) discharged from a hospital within the preceding 90 days; Group C) receiving nursing care and had poor performance status; and Group D) receiving regular endovascular treatment.

Results: Chest radiography was inferior to HRCT for the identification of pneumonia (149 vs 208 cases, \( p < 0.0001 \)). Among the designated NHCAP criteria, chest radiography identified pneumonia cases at a significantly lower frequency than HRCT in Group A (70 vs 97 cases, \( p = 0.0190 \)) and Group C (86 vs 136 cases, \( p < 0.0001 \)). The detection failure rate of chest radiography differed among NHCAP criteria: 27.8% in Group A, 26.5% in Group B, 36.7% in Group C and 5.8% in Group D. Cerebrovascular disease and poor functional status were significantly more frequent in patients in Groups A and C compared with those in...
CT is superior to chest radiographs

162 patients with suspected **NHCAP**
- 147/162 (90.6%): pneumonic infiltration diagnosed by CT
- **10.2%** (15/147): no pneumonic infiltration on CXR

For diagnosing and evaluating the severity of **elderly CAP**

142 patients with 65 years of age or older and hospital admission for suspected CAP.
- 127/142 (89.4%): diagnosed by CT
- **9.4%** (12/127): no pneumonic infiltration on CXR
- In 127 CAP, bilateral pneumonic infiltration are more frequently detected by CT in non-survivors than survivors (79.0% vs. 53.7%; p <0.05)
Negative chest radiographs do not exclude pneumonia.
→ Early chest CT can provide more valuable information for elderly HCAP.
89/M, nursing home, Pneumonia + Previous TB + Centrilobular emphysema + Pulmonary edema + Pleural effusion

Problems to depict current pneumonia due to multiple comorbidities
Radiologic Differential Diagnosis

Pneumonia vs / and

- Atelectasis
- Pulmonary edema
- Tuberculosis
- Neoplasm
- Drug-induced lung disease
- Organizing pneumonia
- ARDS

Not all opacity in the lung is pneumonia.

Diagnosis of pneumonia can be complicated by other diseases showing lung opacities.

In patients with suspected HCAP, radiologists will try to depict current pneumonia among other different diseases.
Atelectasis vs/and Pneumonia

65/M, Pneumonia:
Heterogeneous, less enhanced consolidation

72/F, Atelectasis:
Homogeneous, highly enhanced consolidation

Atelectasis >> Pneumonia
• Volume loss
• Vessel or airway crowding
• Homogeneous enhancement of nonaerated lung on CT
Pulmonary edema vs/and Pneumonia

Pulmonary edema >> Pneumonia

- Bilateral and symmetric, interstitial or airspace opacities
- Cardiomegaly
- Pleural effusion

82/M
CKD and IPF, Pulmonary edema

81/M
Sepsis, Pneumonia

Pulmonary edema can mimic pneumonia and coexist with pneumonia.
Pulmonary tuberculosis vs/and HCAP

Concomitant TB and HCAP
• higher PSI scores
• more acute respiratory failure
• higher in-hospital mortality
• 21/701 (3%) of hospitalized HCAP patients have concomitant TB

PLoS ONE 2012;7:e36832

Elderly patients with pulmonary TB
TB In the elderly become an increasingly important problem

More likely to present with
• negative sputum smears
• cavity negative lesions
• lower lung field involvement
• pleural effusion

Infection 2008;36:335
32
Pneumonia
+ TB +
pulmonary edema

73/M
TB

78/M
Pneumonia
+ TB +
pulmonary edema
Lung cancer vs/and Pneumonia

Invasive mucinous adenocarcinoma (mucinous BAC) >> Pneumonia

- Stretching and sweeping of branching air-filled bronchi within consolidation
- Bulging contour
- CT angiogram sign

<table>
<thead>
<tr>
<th>CT features</th>
<th>Number of patients (%) With BAC (n=18)</th>
<th>Number of patients (%) With pneumonia (n=29)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground-glass attenuation</td>
<td>12 (67)</td>
<td>22 (76)</td>
<td>0.74</td>
</tr>
<tr>
<td>Marginal conspicuity</td>
<td>13 (72)</td>
<td>23 (79)</td>
<td>0.72</td>
</tr>
<tr>
<td>CT angiogram sign</td>
<td>8 (44)</td>
<td>14 (48)</td>
<td>0.52</td>
</tr>
<tr>
<td>Air-bronchogram sign</td>
<td>12 (67)</td>
<td>21 (72)</td>
<td>0.75</td>
</tr>
<tr>
<td>Bubble-like low attenuation</td>
<td>14 (78)</td>
<td>6 (21)</td>
<td>0.01*</td>
</tr>
<tr>
<td>Pleural thickening</td>
<td>6 (33)</td>
<td>29 (100)</td>
<td>0.01*</td>
</tr>
<tr>
<td>Pleural retraction</td>
<td>10 (56)</td>
<td>7 (24)</td>
<td>0.06</td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>0 (0)</td>
<td>4 (14)</td>
<td>0.28</td>
</tr>
<tr>
<td>Extrapleural fatty hypertrophy</td>
<td>0 (0)</td>
<td>6 (21)</td>
<td>0.07</td>
</tr>
<tr>
<td>Bronchial wall thickening</td>
<td>4 (22)</td>
<td>24 (83)</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

Eur Radiol 2006;16:1763
34/F, Mucinous adenocarcinoma with lepidic pattern

82/F, Pneumonia with parapneumonic effusion

76/F, Mucinous adenocarcinoma with lepidic pattern
Along with the rapid rise in the elderly population, the need for healthcare in the elderly population will rise quickly.

The elderly are vulnerable to pneumonia.

Elderly HCAP show more severe pneumonia, more drug-resistant pathogens, and worse clinical outcomes.

Aspiration pneumonia is an important pathogenesis of elderly HCAP.

Bronchopneumonia pattern with gravity dependent distribution is common in elderly HCAP.

Difficulties in radiologic assessment of elderly HCAP are due to false negative findings on initial chest radiographs and clinical overlapping pathology with multiple comorbidities.

Early chest CT can provide more valuable information for elderly HCAP.
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Deadline for Early Registration: August 31 (Thu)
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