Investigation and management of pneumonia

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Dr Ewen Ross
Investigation and management of pneumonia - summary

To discuss

- Varying presentations of pneumonia
- Causative factors
- Severity risk factors

- Investigations
- Management
- Complications
Patient AB

- 61 year old smoker
- 2 weeks dry cough
- Sweats
- R pleuritic chest pain

- Attended GP
  - Voltarol
- Second GP
  - amoxicillin

In A&E
- Flushed
- Pyrexial 39°C
- Pulse 130 bpm
- Resp Rate 46/min
- $\text{SpO}_2$
  - 80% on air
  - 90% on 4 litres $\text{O}_2$
Signs & symptoms

- Symptoms
  - Cough
  - Fever $>38^\circ C$
    - Myalgia
    - Headache
  - Pleural pain
  - Dyspnoea/tachypnoea

- Signs
  - Focal signs
    - Crackles (coarse)
    - Consolidation
      - Dull to percussion
      - Bronchial breathing
      - Whispering pectoriloquy
AB CXR
C(U)RB-65

- Confusion
- (Urea > 7 mmol/l)
- Resp Rate > 30
- BP
  - <90 mmHg syst
  - <60 mmHg diast
- Age >65
## C(U)RB-65

Score 1 for each
- Confusion
- (Urea > 7 mmol/l)
- Resp Rate > 30
- BP
  - <90 mmHg syst
  - <60 mmHg diast
- Age >65

<table>
<thead>
<tr>
<th>Score</th>
<th>Mortality/ITU admission %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.7</td>
</tr>
<tr>
<td>1</td>
<td>3.2</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>41</td>
</tr>
<tr>
<td>5</td>
<td>57</td>
</tr>
</tbody>
</table>
C(U)RB-65

- Confusion: Mr AB No
- (Urea > 7 mmol/l): No
- Resp Rate > 30: Yes
- BP
  - <90 mmHg syst: 117
  - <60 mmHg diast: 65
- Age > 65: 61 years

Score 1
Additional severity indicators

- Hypoxia
- Evidence that some patients in low risk groups may progress to HDU/ITU care

Current recommendations
- CRB-65 score 0 - manage at home
- CRB-65 1 or 2 – refer/admit
- CRB-65 3 or more – urgent admission
A.B.

- **Examination**
  - RR ↑ c. 40/min
  - ↓ breath sounds R lower zone
  - Bronchial breathing R lower zone

- **Investigations**
  - ↑ WCC 15.5 x10⁹/l
    - Neutr 12.2 x10⁹/l
  - ↑ CRP 357 mmol/l
  - ↑ GGT 318 mmol/l
  - ↑ Alk Phos 427 mmol/l
  - ↓ albumin 20mmol/l
  - Na⁺ 139 mmol/l
Diagnosis

Community Acquired Pneumonia
A.B.

- IV Clarithromycin given as bolus IV by mistake instead of Co-Amoxiclav
  - Painful swollen left arm

- Admitted to Acute Medicine for IV antibiotics
- Transferred to Medical Ward
Pneumonia

“Inflammation of the lung”

- Bacterial
  - Including TB
- Viral
- Cryptogenic
  - Cryptogenic Organising Pneumonia (COP/BOOP)
- Interstitial
  - 2° to auto-immune disease – SLE / RA etc
  - 2° to smoking (DIP & RB-ILD)
  - Idiopathic - UIP
Bacteriology

<table>
<thead>
<tr>
<th></th>
<th>Community (1 study*, n=236)</th>
<th>In hospital (5 studies†, n=1137)</th>
<th>Intensive care unit (4 studies‡ n=185)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (%)  95% CI</td>
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</tr>
<tr>
<td><em>S. pneumoniae</em></td>
<td>36.0  29.9 to 42.1</td>
<td>39  36.1 to 41.8</td>
<td>21.6  15.9 to 28.3</td>
</tr>
<tr>
<td><em>H. influenzae</em></td>
<td>10.2  6.3 to 14.0</td>
<td>5.2  4.0 to 6.6</td>
<td>3.8  1.5 to 7.6</td>
</tr>
<tr>
<td><em>Legionella spp</em></td>
<td>0.4  0.01 to 2.3</td>
<td>3.6  2.6 to 4.9</td>
<td>17.8  12.6 to 24.1</td>
</tr>
<tr>
<td><em>S. aureus</em></td>
<td>0.8  0.1 to 3.0</td>
<td>1.9  1.2 to 2.9</td>
<td>8.7  5.0 to 13.7</td>
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<tr>
<td><em>M. catarrhalis</em></td>
<td>?</td>
<td>1.9  0.6 to 4.3</td>
<td>?</td>
</tr>
<tr>
<td>Gram negative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>enteric bacilli</td>
<td>1.3  0.3 to 3.7</td>
<td>1.0  0.5 to 1.7</td>
<td>1.6  0.3 to 4.7</td>
</tr>
<tr>
<td><em>M. pneumoniae</em></td>
<td>1.3  0.3 to 3.7</td>
<td>10.8  9.0 to 12.6</td>
<td>2.7  0.9 to 6.2</td>
</tr>
<tr>
<td><em>C. pneumoniae</em></td>
<td>?</td>
<td>13.1  9.1 to 17.2</td>
<td>?</td>
</tr>
<tr>
<td><em>C. psittaci</em></td>
<td>1.3  0.3 to 3.7</td>
<td>2.6  1.7 to 3.6</td>
<td>2.2  0.6 to 5.4</td>
</tr>
<tr>
<td><em>C. burnetii</em></td>
<td>0  0 to 1.6</td>
<td>1.2  0.7 to 2.1</td>
<td>0  0 to 2.0</td>
</tr>
<tr>
<td>All viruses</td>
<td>13.1  8.8 to 17.4</td>
<td>12.8  10.8 to 14.7</td>
<td>9.7  5.9 to 14.9</td>
</tr>
<tr>
<td><em>Influenza A &amp; B</em></td>
<td>8.1  4.9 to 12.3</td>
<td>10.7  8.9 to 12.5</td>
<td>5.4  2.6 to 9.7</td>
</tr>
<tr>
<td>Mixed</td>
<td>11.0  7.0 to 15.0</td>
<td>14.2  12.2 to 16.3</td>
<td>6.0  3.0 to 10.4</td>
</tr>
<tr>
<td>Other</td>
<td>1.7  0.5 to 4.3</td>
<td>2  1.3 to 3</td>
<td>4.9  2.3 to 9.0</td>
</tr>
<tr>
<td>None</td>
<td>45.3  30.0 to 51.7</td>
<td>30.8  28.1 to 33.5</td>
<td>32.4  25.7 to 39.7</td>
</tr>
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<td>Haemophilus influenzae</td>
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<td>S. aureus</td>
<td>0.8</td>
<td>0.1 to 3.0</td>
<td>1.9</td>
</tr>
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Streptococcus pneumoniae
Gram +ve cocci

Haemophilus influenzae
Gram –ve rod

Legionella spp
Gram –ve intracellular parasite
Mycoplasma pneumoniae

Slow growing obligate parasite

Figure 4  Laboratory reports of mycoplasma infections to the Communicable Disease Surveillance Centre, England and Wales, 1990–2000 (4 weekly)\textsuperscript{11} [II].
Community Acquired Pneumonia

- **Community**
  - Symptoms of LRTI (*cough*, dyspnea, tachypnea, pleural pain etc.)
  - New focal chest signs on examination
  - Systemic features (temperature, sweats/shivers aches etc.)
  - No other explanation

- **Hospital**
  - Associated with new CXR shadowing
Community Acquired Pneumonia

- **Incidence**
  - 5-11 per 1000 adults annually
  - 5-12% of adult LRTI seen in GP
  - 5-10% need ITU

- **Mortality**
  - Community <1%
  - Hospital 6-12%
  - ITU >50%
Investigations

○ Community
  ● No routine bacteriology
  ● Sputum if slow to settle
  ● Consider TB
  ● Serology is specific situations
    ○ Outbreaks
    ○ Clinical situation

○ Hospital
  ● General
    ○ CXR, FBC, Biochem, CRP, SpO₂/PaO₂
  ● Microbiology
    ○ Depends on severity
      ● Blood culture
      ● Sputum
      ● Serology
        ○ Pneumococcal ag, mycoplasma and legionella ag
Severity

C(U)RB-65
- Confusion
- (Urea > 7 mmol/l)
- Resp Rate > 30
- BP
  - <90 mmHg syst
  - <60 mmHg diast
- Age >65

- Additional risk factors
  - Co-existing disease
  - Hypoxia
  - WCC <4 or > 20 x10^9
  - Bilateral or multilobar involvement
Management

○ Community
  ● Antibiotics
  ● Pleuritic pain
    ○ analgesia
  ● Nutrition
  ● Review
  ● Refer if fail to improve

○ Hospital
  ● Oxygen
    ○ $\text{SpO}_2 > 92\%$
    ○ $\text{PaO}_2 > 8\text{kPa}$
  ● High flow $\text{O}_2$ safe if uncomplicated
  ● May need IV fluids
  ● Nutrition
  ● Monitor
    ○ Temp, RR, P, BP
    ○ $\text{SpO}_2, \text{FiO}_2 \text{ at least twice daily}$
Antibiotics

○ Community
  ● Amoxicillin
    ○ 1st choice
  ● Macrolide
    ○ (clarithromycin)
    ○ Alternative for penicillin sensitive

○ Hospital
  ○ Non-severe
    ● Oral is usually OK
    ● Combined amoxicillin and macrolide (7 days)
  ○ Severe
    ● IV antibiotics
      ○ Co-amoxiclav or ceftriaxone PLUS macrolide (10 days)
A.B.

- Temperature did not settle
- Ongoing R pleuritic pain
- Dull to percussion
Complications of pneumonia

- Parapneumonic effusion
  - AB
    - LDH
    - pH
  - Organism on culture:
    - LDH 2537 mmol/l
    - No growth

- Empyema
  - LDH
  - pH
  - Organism on culture
Respiratory Review

- Confirmed clinical signs
- Ultrasound of chest
- Posterior collection
- Intercostal drainage
A.B.

- 750ml turbid fluid drained
- Some resolution on CXR
  - Concerns about loculated collection
- Drain removed

- Irregular discharge against advice
  - GP contacted – advised about concerns
  - GP attended patient – oral antibiotics
  - OP follow-up arranged
A.B.

- Attended OP 12 days later
  - Not well
  - Pleuritic chest pain
  - No fevers, but night sweats

- CXR
A.B.

- Referred to Thoracic Surgery
- Thoracotomy and decortication of empyema
Community- acquired pneumonia - conclusions

- Diagnosis
  - Clinical & radiological
- Assess severity
  - CRB-65
- Prompt treatment
  - Empirical antibiotics
- Monitor
  - Complications
  - Alternative diagnosis (e.g. lung cancer)
Patient CD

- Normal CT head
- Not ventilated.

- Smoker. IVDU, alcohol user, HIV-ve
- SpO2 94% in A+E
- CXR: Hyperinflated chest, nil focal
Patient CD

- Commenced on oral amoxycillin as cough p/o green sputum on admission
- Asked to review at 72 hours post-admission
Clinical Scenario 2

- Pyrexial, temp 38.2 C
- Tachycardic, pulse 120pm, normotensive
- Resp rate 26 pm, crackles in LLZ posteriorly on auscultation of chest
- SpO2 89% on 35% oxygen
Consider differential diagnosis

- Hospital-acquired pneumonia
- Pulmonary embolism
- Pulmonary oedema
  - Cardiogenic
  - Non-cardiogenic – Fluid overload
- Aspiration / inhaled foreign body
- Pulmonary haemorrhage
- Lung lobar collapse
- Exacerbated COPD/pre-existing chest problem
Investigating possible hospital – acquired pneumonia (HAP)

- **History**
  - Risk factors for HAP
    - Time in hospital
    - Primary diagnosis
    - Comorbidities
    - Antibiotic use to date

- **Exam**
  - Temperature, Blood pressure,
  - Respiratory rate and effort
  - Chest auscultation
Investigating possible hospital – acquired pneumonia

- Investigations
  - CXR
  - FBC – WCC high or low
  - U+E – Renal Function
  - ABGs
  - Microbiological tests
    - Respiratory secretions
    - Blood cultures
Investigating possible hospital – acquired pneumonia

- CXR useful – if normal, excludes HAP
- Obtain good quality CXR and compare with previous
- Consider CT in complex cases
Hospital-acquired pneumonia - background and significance

- Common
- High morbidity and mortality
  - Aim to deliver early, appropriate and adequate therapy

- Most evidence for ventilator-associated pneumonia rather than more common, less severe variant
## Hospital-acquired pneumonia – Diagnostic criteria

Clinical diagnosis is difficult but should be considered in the presence of the following criteria:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>New and/or persistent infiltrate on CXR</td>
<td>Increased oxygen requirement</td>
</tr>
<tr>
<td>Core temperature &gt;38.3 °C, secretions, and CXR change</td>
<td>Cough</td>
</tr>
<tr>
<td>Temp &lt;36.0 °C or &gt;38.3 °C</td>
<td>Increased respiratory rate</td>
</tr>
<tr>
<td>Purulent sputum/tracheal secretions</td>
<td>Purulent tracheal secretions</td>
</tr>
<tr>
<td>WCC high (&gt;12,000/mm³) or low (&lt;4,000/mm³)</td>
<td>Confused patient</td>
</tr>
<tr>
<td></td>
<td>Other organ failure</td>
</tr>
</tbody>
</table>
Severe HAP - definitions

- Admission to ICU
- Requirement for > 35% O2 to maintain SpO2 > 90%
- CXR – rapid progression, multilobar involvement, cavitation
- Severe sepsis/end organ failure
  - Systolic < 90 or diastolic < 60
  - Urine output < 20ml/h or < 80ml in 4 h
  - Acute renal failure requiring dialysis
Microbiological surveillance in suspected hospital-acquired pneumonia

<table>
<thead>
<tr>
<th>Predominant Pathogens*</th>
<th>USA (NNISS)</th>
<th></th>
<th>Europe (EPIC)</th>
<th>France (Eole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>a</td>
<td>a</td>
<td>b</td>
<td>c</td>
</tr>
<tr>
<td>Gram-negatives</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pseudomonas</em> aerea/spp.</td>
<td>17.2</td>
<td>16</td>
<td>21</td>
<td>29.8</td>
</tr>
<tr>
<td>E. coli</td>
<td>6.4</td>
<td>4</td>
<td>4</td>
<td>6.8</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>7.4</td>
<td>7</td>
<td>8</td>
<td>8.0</td>
</tr>
<tr>
<td>Enterobacter spp.</td>
<td>10.4</td>
<td>11</td>
<td>9</td>
<td>7.9</td>
</tr>
<tr>
<td>Serratia spp.</td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other enterobacteria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haemophilus</td>
<td></td>
<td>6.4</td>
<td>5</td>
<td>10.2</td>
</tr>
<tr>
<td>influenzae</td>
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<td></td>
</tr>
<tr>
<td>Acinetobacter spp.</td>
<td></td>
<td>4</td>
<td>6</td>
<td>9.9</td>
</tr>
<tr>
<td>Gram-positives</td>
<td></td>
<td></td>
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<tr>
<td>Staphyloccocus aureus</td>
<td>14.6</td>
<td>20</td>
<td>20</td>
<td>31.7</td>
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<tr>
<td>Other staphylococci</td>
<td></td>
<td>1</td>
<td></td>
<td>10.6</td>
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<tr>
<td>Streptococcus pneumoniae</td>
<td></td>
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<tr>
<td>Other Streptococci</td>
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<tr>
<td>Enterococci</td>
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</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td>14.0</td>
</tr>
</tbody>
</table>

Table 1. Frequency of organisms isolated from patients with suspected HAP in the US. National Nosocomial Infections Surveillance System (NNISS - 1985-1997), the European EPIC study (1992) and the Eole French study (2002)
## Risk factors for specific organisms – ATS criteria (ITU patients)

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mild to moderate HAP</strong></td>
<td></td>
</tr>
<tr>
<td>Witnessed aspiration, recent abdo surgery</td>
<td>Anaerobes</td>
</tr>
<tr>
<td>Coma, head trauma, recent flu, IVDU, DM, renal failure</td>
<td>Staph aureus</td>
</tr>
<tr>
<td>High dose steroids</td>
<td>Legionella</td>
</tr>
<tr>
<td>Prolonged ITU stay, steroids, antibiotics, structural lung disease</td>
<td>P aeruginosa</td>
</tr>
<tr>
<td><strong>Severe HAP</strong></td>
<td></td>
</tr>
<tr>
<td>Antibiotics + ventilation</td>
<td>Acinetobacter</td>
</tr>
<tr>
<td>Antibiotics + ventilation; steroids, malnutrition, structural lung disease, long stay</td>
<td>P aeruginosa</td>
</tr>
<tr>
<td>Antibiotics + prolonged ventilation</td>
<td>MRSA</td>
</tr>
</tbody>
</table>
Interpreting microbiological results

- Difficult to distinguish between colonisation, contamination and infection
- Where likely organism isolated from respiratory specimen, it should be treated
- The significance of unlikely organisms or organisms from blood culture require careful consideration
- No evidence that invasive sampling better than noninvasive
Antimicrobial therapy for hospital-acquired pneumonia

- No evidence that directed therapy better than early empirical therapy based on local surveillance data even in ventilator-associated infections

- Commencement of therapy should not be delayed while waiting for microbiological data

- Use local guidance regarding empirical therapy
Antimicrobial therapy for hospital-acquired pneumonia

NOTE – advice changes frequently – discuss with microbiologist when in doubt

- Empirical 1st line therapy in unwell patient
  - Ceftriaxone 2g IV once daily
- If pseudomonas /other G-ve likely
  - ADD gentamicin
- If atypical organism suspected
  - ADD clarithromycin
- If MRSA suspected
  - ADD vancomycin
Hospital-acquired pneumonitis - conclusions

- Be vigilant in at-risk patients

- Consider differential diagnoses when confronted by possible HAP

- Simple tests useful (CXR, sputum culture)

- Treat early and consider empirical therapy to cover likely organisms
Investigation and management of pneumonia - summary

- To discuss
  - Varying presentations of pneumonia
  - Causative factors
  - Severity risk factors
  - Investigations
  - Management
  - Complications
Any Questions?