Community Acquired Pneumonia – risk assessment and evidenced based pathways

Dr Steven Lindstrom
Department of Respiratory Medicine
Outline

- Introduction
- Pneumonia Severity Index (PSI)
- St George Hospital
  - Audit and experience Jul-Dec 2003
- CURB-65 Severity Index
- SMART-COP scoring system
Introduction

- Community-acquired pneumonia
  - Common
  - Increases with age
  - Morbidity and mortality
  - Lost days of work
  - Substantial costs
Economic Consideration

- Significant
- Major factor in the cost of care is the site-of-care decision
  - Most patients (80%) are treated out of hospital
  - Majority of cost (95%) is attributed to patients admitted

Niederman, *Clin Ther.* 1998
Hospital Admission

- Admission rates for pneumonia vary markedly between different regions
- Physicians tend to
  - Rely on subjective impressions to decide on site of care
  - Overestimate the risk of death in pneumonia
- Admit patients with low mortality risk

Fine et al. Arch Intern Med
Questions

- Who should be admitted to the hospital?
- Who can be discharged home safely?
- Are there guidelines we can follow?
- Applicable to which group of patients?
- Should admission decision remain an “art-of-medicine” decision?
- Do these guidelines help reduce hospital admissions and reduce costs?
Pneumonia Management Guidelines

- American Thoracic Society
- British Thoracic Society
- Canadian Infectious Disease Society
- Infectious Diseases Society of America (IDSA)
- Australian Therapeutic Guidelines
Pneumonia Severity Guidelines

- Assessment of prognosis
- Selection of an appropriate site of care
- Antibiotic guidance
Criteria for Quality Guideline

- Ease of use
- Clinical and laboratory criteria
- Clearly defined exclusions
- Prediction rule
  - Safety
  - Accuracy
  - Effectiveness
- Prospectively tested
Pneumonia Severity Index (PSI)

Pneumonia Severity Index

Demographic factor

- Age
  - Men
  - Women

- NH resident

Coexisting illnesses

- Neoplastic disease
- Liver disease
- CCF
- Cerebrovascular disease
- Renal disease

Points in years
- +30
- +20
- +10
- +10
- +10

Points in years – 10
- +10
- +10
Pneumonia Severity Index

- **Physical examination findings**
  - Altered mental state +20
  - RR ≥ 30 +20
  - Systolic BP < 90 +20
  - Temp < 35 or ≥ 40 +15
  - Pulse ≥ 125 +10

- **Lab findings**
  - Arterial pH < 7.35 +30
  - Blood urea ≥ 11 +20
  - Na < 130 +20
  - Glucose ≥ 14 +10
  - Haematocrit < 30% +10
  - paO₂ < 60 +10
  - Pleural effusion +10
<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>&lt; 50 years old with no points scored</td>
</tr>
<tr>
<td>Class II</td>
<td>&lt; 71 points</td>
</tr>
<tr>
<td>Class III</td>
<td>71-90 points</td>
</tr>
<tr>
<td>Class IV</td>
<td>91-130 points</td>
</tr>
<tr>
<td>Class V</td>
<td>&gt;130 points</td>
</tr>
</tbody>
</table>
Pneumonia Severity Index

- Derivation cohort of 14,199 patients with pneumonia
- 2 independent populations for external validation
  - 38,039 patients
  - 2,287 patients prospectively

Pneumonia Severity Index

Classification

- Stratify patients into 5 classes for risk of death from all causes within 30 days of presentation

<table>
<thead>
<tr>
<th>Class</th>
<th>Mortality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>0.1%</td>
</tr>
<tr>
<td>Class II</td>
<td>0.6%</td>
</tr>
<tr>
<td>Class III</td>
<td>2.8%</td>
</tr>
<tr>
<td>Class IV</td>
<td>8.5%</td>
</tr>
<tr>
<td>Class V</td>
<td>31.1%</td>
</tr>
</tbody>
</table>
Pneumonia Severity Index

Admission Strategies

Class I, II   Outpatient
Class III    Brief observation or outpatient
Class IV, V  Inpatient

- Reduced admissions by 31%
- Mortality of outpatients <1%
- ICU admission of outpatients 4.3%
Additional margin of safety
- Include all Class I, II, III patients with hypoxaemia for inpatient care
- Mortality of outpatients <1%
- Proportion admitted to ICU reduced to 1.6%
Pneumonia Severity Index

Limitations

- Some variables over-simplified
  - Eg. SBP 45mmHg and 85mmHg have markedly different implication
- Heavily age weighted
- Time consuming
- Excludes
  - Children, pregnant women
  - Immunocompromised
  - Nosocomial or aspiration pneumonia
- Intended to supplement rather than override clinical judgement
Pneumonia Severity Index

Effectiveness and Safety

- Randomised trial
- 19 Canadian hospitals, 1743 patients
- Patients presented to ED with CAP
- 18% decrease in admission of low risk patients (class I, II and III)
- No negative effects on adverse medical outcomes
  - ICU admission, mortality, readmission, complications

Marrie, JAMA 2000
Clinical Example 1:

- 86 y.o. male from home presents with a 2 day history of cough, minor yellow sputum, chills and sweats
- No chest pain or dyspnoea
- Known hypertension and chronic renal impairment
- Ex smoker quit 40 years ago (15 pack year history)
- Medications include Amlodipine 5mg daily and Ibersartan 300mg daily
Examination:

- Talking full sentences
- Temp 38.2°C, BP 150/90, Pulse 100/min
- RTA, Resp rate 18/min, Oxygen saturation of 95% room air
- Medium intensity crackles right axillary region
- Cardiac exam, abdomen NAD
Investigations

- Chest x-ray showed patchy changes of consolidation right middle lobe
- UEC showed creatinine of 145umol/L, urea 13.1mmol/L, Na 133
- FBC showed total WCC of 14 with 80% neutrophils, mild anaemia Hb 111g/L with normal MCV
- Blood cultures and sputum cultures taken
Overall assessment

- PSI score of 96 = Class IV pneumonia
- The guideline pathway would suggest inpatient care which was followed
- 24 hours of IV Penicillin and oral Roxithromycin given
- Temp fell below 37.8°C for 16 hours and patient’s obs remained fine, fully ambulant, O2 sats remained above 95%
- Safe for discharge home, no social issues
Example 2

- 35 year old gardener presents with a 3 day history of fever with some chills and rigors
- Dyspnoea progressing over the course of the morning before presenting to ED
- No pleuritic chest pain, cough not productive
- Non-smoker
- Usually well, had been returfing a rugby field 5 to 7 days before onset of illness
Physical examination

- Appeared unwell, not confused, flushed temp 39.5°C, resp rate 40 per minute, O2 saturation of 92% room air, BP 95/55, pulse 110 per min sinus rhythm
- Reduced air entry over lower lobes, extensive inspiratory crackles
- Cardiac exam normal, no abdominal tenderness
Investigations

- Chest x-ray: extensive consolidation both lower lobes
- FBC: total WCC of 16 with neutrophilia (toxic granulation), Hb and platelets normal
- UEC: Na+ 132mmol/L otherwise normal
- Liver function: mild ↑ AST, ALT and GGT
- Blood cultures taken, legionella and pneumococcal Ur Ag negative
Overall Assessment

- Personal experience = worry as patient unwell!!
- PSI score 55 = Class II = safe for discharge!

PROGRESS:
- Admitted HDU, commenced Ceftriaxone and Azithromycin intravenously
- Progressed to needing high flow O2 then a brief trial of bilevel CPAP (fortunately not intubated)
DIAGNOSIS?????
St George Hospital

Pneumonia pathway compliance
July-December 2003
Published RW Lee & ST Lindstrom
Respirology 2007, 12:754-758
Introduction

- Implementation of the PSI and antibiotic guideline for St George Hospital from March 2003
- Proactive education of admitting medical registrars and emergency staff
- Scoring Sheet and antibiotic guideline readily available
Aim

- Retrospective audit of community-acquired pneumonia
  - Demographics
  - PSI classification
  - Mortality rate
  - Length of hospital stay
  - Compliance with
    - PSI scoring
    - Antibiotic guideline
Inclusions

- All patients with primary admitting diagnosis of community-acquired pneumonia
  - Jul-Dec 2003
- Pneumonia definition
  - presence of new pulmonary infiltrate
    - plus 2 of following
  - cough, dyspnoea, sputum production, pleuritic chest pain, lethargy
Number of Admissions

- Total: 137
- Respiratory: 103 (75%)
- Aged Care: 20
- Emergency: 13
- ICU: 1
- ICU admission: 8
Demographics

Sex
- Male 73 (53%)
- Female 64 (47%)

Median Age
- Male 77 years
- Female 78.5 years
- Community 73 years
- Nursing Home 85.5 years

St George Hospital. Pneumonia Audit Jul-Dec 2003
Demographics

Place of Residence

- Community: 101
- Nursing Home: 36
Comorbidity

Chronic Lung Diseases 35 (26%)
CCF 25 (18%)
CVD 17 (12%)
Cancer 12 (8.8%)
CRF 7 (5.1%)
Immunosuppressed 8 (5.8%)
IVDU/Alcohol Abuse 5 (3.6%)

St George Hospital. Pneumonia Audit Jul-Dec 2003
# Laboratory Findings

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoxia $pO_2 &lt; 60$ mmHg</td>
<td>92</td>
<td>67%</td>
</tr>
<tr>
<td>Acidosis $pH &lt; 7.35$</td>
<td>19</td>
<td>14%</td>
</tr>
<tr>
<td>Single-Lobe Pneumonia</td>
<td>97</td>
<td>71%</td>
</tr>
<tr>
<td>Multi-Lobe Pneumonia</td>
<td>40</td>
<td>29%</td>
</tr>
<tr>
<td>Pleural Effusion</td>
<td>27</td>
<td>20%</td>
</tr>
</tbody>
</table>
## Microbiology

### Sputum
- Non-productive: 82 (60%)
- Negative: 45 (33%)
- Pathogen identified: 10 (7%)

### Blood Cultures
- Not performed: 13 (10%)
- Negative: 118 (86%)
- Pathogen identified: 6 (4%)
## Serology

### Respiratory Pathogens Serology

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not performed</td>
<td>108</td>
<td>(79%)</td>
</tr>
<tr>
<td>Negative</td>
<td>25</td>
<td>(18%)</td>
</tr>
<tr>
<td>Mycoplasma</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Legionella</td>
<td>1</td>
<td>(3%)</td>
</tr>
<tr>
<td>Chlamydia</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Influenza</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Class</td>
<td>Number</td>
<td>Mortality Rate</td>
</tr>
<tr>
<td>----------</td>
<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td>Class I</td>
<td>7</td>
<td>0%</td>
</tr>
<tr>
<td>Class II</td>
<td>21</td>
<td>0%</td>
</tr>
<tr>
<td>Class III</td>
<td>28</td>
<td>3.7%</td>
</tr>
<tr>
<td>Class IV</td>
<td>39</td>
<td>7.7%</td>
</tr>
<tr>
<td>Class V</td>
<td>43</td>
<td>44%</td>
</tr>
</tbody>
</table>

Nursing Home Residents Mortality  36%
Class I to III Admissions

- Hypoxia: 17
- Other medical problems: 16
- Non-compliance: 12
- Uncertain diagnosis: 2
- Poor oral intake: 1
Nursing Home Residents

- Total: 36
- PSI Class IV: 11
- PSI Class V: 25

- Average PSI Score NH Residents: 154
- Average PSI Score Community: 94

- Median LOS NH Residents: 4 days
- Median LOS Community: 6 days
PSI Scoring Performance

Total  33%
- Community  35%
- NH Residents  29%

Department
- Respiratory  38%
- Geriatrics  15%
- Emergency  23%
PSI Scoring Performance

Total 45
- Correctly performed 26 (58%)
- Incorrectly performed 19 (42%)
  - No change to Class 9
  - Class lower 3
  - Class higher 7

St George Hospital. Pneumonia Audit Jul-Dec 2003
Antibiotic Guideline Compliance

- NH Residents 58%
- Community patients 77%
- PSI performed 87%
- PSI not performed 67%

St George Hospital. Pneumonia Audit Jul-Dec 2003
Obstacles to Compliance

- Lack of awareness
- Access of PSI score sheet and guideline
- Complex scoring method and too many variables
- Other available guidelines maybe conflicting
- Concurrent medical problems needing treatment
Summary of Study

- Mortality rate similar to original PSI cohort
- Significant numbers of Class I to III admissions
- Poor compliance of PSI scoring
- Significant numbers of incorrect calculations
- Poor compliance with antibiotic guideline
CURB-65 score

Defining Community Acquired Pneumonia Severity: International Derivation and Validation Study
Lim et al. Thorax 2003; 58
Aim

- Derive and validate a practical severity assessment model
- Stratify adults hospitalised with CAP into different management groups
Design

- 3 prospective studies of CAP retrospectively combined
  - UK \( n = 362 \)
  - NZ \( n = 452 \)
  - Netherlands \( n = 254 \)
- CAP defined as acute respiratory illness associated with new radiologic infiltrate
- Main outcome: 30 day mortality
Design

Exclusions

- Pneumonia was
  - Not the primary cause for admission
  - An Expected terminal event
  - Distal to bronchial obstruction
- Tuberculosis, bronchiectasis, solid organ and haematological malignancies, HIV or immunocompromised
- Hospital admission within previous 14 days
- Nursing home residents
Statistical Analysis

- Combined data of 1068 patients randomised
  - Derivation cohort (80%)
  - Validation cohort (20%)
- Univariate association between mortality and potential predictor variable was analysed
- CURB score was then categorised and validated
CURB-65

- Confusion
- Urea > 7 mmol/L
- Respiratory rate ≥ 30/min
- Blood pressure (SBP < 90 or DBP ≤ 60)
- Age ≥ 65

1 point score for each prognostic sign
CURB-65 score: One step strategy for stratifying patients with CAP

0 or 1
Group 1: Mortality Low (1.5%)
Likely suitable for home treatment

2
Group 2: Mortality Intermediate (9.2%)
Consider hospital treatment
Short stay

3 or more
Group 3: Mortality High (22%)
Manage inpatient
Consider ICU
Limitations of CURB-65

- Tested in small retrospective cohorts only
- Poorly predictive in elderly patients
- Performs better at identifying the severely ill
Antibiotic management linked to SMART-COP clinical scoring system

Scoring system published P Charles et al, Clin Infect Dis 2008;47:375-84

Scoring system developed in Australia but with international expert involvement (ACAPS)

Prospective, multi-centre, observational study
SMART-COP

- Univariate and multi-variate analyses to determine the risk of requiring Intensive Respiratory or Vasopressor Support (IVRS)
- Weighted major and minor criteria according to beta coefficients
- 882 episodes of CAP involving 862 patients
- IRVS required in 91 or 10.3% (ICU admission in 118 or 13.4%)
SMART-COP Derivation

- Of those requiring IRVS, 58% admitted from ED and 42% initially admitted from the ward
- 30 day mortality was 3.7% or 50/862
- 14 of patients requiring IRVS died
- PSI class IV and V predicted 74% and CURB-65 group 3 predicted 38.5% of those requiring IVRS
<table>
<thead>
<tr>
<th>Letters</th>
<th>Condition Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Systolic BP &lt; 90mmHg</td>
<td>2</td>
</tr>
<tr>
<td>M</td>
<td>Multi-lobar CXR signs</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>Albumin &lt;35mg/L</td>
<td>1</td>
</tr>
<tr>
<td>R</td>
<td>Resp Rate – by age</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;50yo RR &gt; 25br/min</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;50yo RR &gt;30 br/min</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>Tachycardia &gt; 125bpm</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>Confusion (acute)</td>
<td>2</td>
</tr>
<tr>
<td>O</td>
<td>Oxygen low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age &lt;50, O2 sats&lt;93%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Age &gt;60, O2 sats &lt;90%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>pH &lt; 7.35 (ABG or VBG)</td>
<td>2</td>
</tr>
</tbody>
</table>
### SMART-COP Interpretation

<table>
<thead>
<tr>
<th>Points</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2 points</td>
<td>Low risk of IVRS</td>
</tr>
<tr>
<td>3-4 points</td>
<td>Moderate risk (1 in 8) of IVRS</td>
</tr>
<tr>
<td>5-6 points</td>
<td>High risk (1 in 3) of IVRS</td>
</tr>
<tr>
<td>7 or greater points (max 11 points)</td>
<td>Very high risk (2 in 3) of IVRS</td>
</tr>
</tbody>
</table>
For primary care physicians
Take out A & P (SMRT-CO)

<table>
<thead>
<tr>
<th>Points</th>
<th>Risk Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 points</td>
<td>Very low risk of needing IVRS</td>
</tr>
<tr>
<td>1 point</td>
<td>Low risk (1 in 20)</td>
</tr>
<tr>
<td>2 points</td>
<td>Moderate risk (1 in 10)</td>
</tr>
<tr>
<td>3 points</td>
<td>High risk (1 in 6)</td>
</tr>
<tr>
<td>4 points or more</td>
<td>High risk (1 in 3)</td>
</tr>
</tbody>
</table>
AUC comparisons for receipt of IVRS
Validation

- 5 external databases totalling over 7000 patients showed good correlations for the need of IVRS
- SMART-COP of 3 points or more
- SMRT-CO of 2 points or more
The FUTURE

To consider an OBJECTIVE & RELIABLE biomarker to discern:

- Presence of bacterial infection
  - Need for initial antibiotics
- Severity of bacterial infection
- Risk of mortality/outcome
- Assist in the stepdown from intravenous to oral antibiotic therapy or cessation of antibiotics
- Reduce hospital stay?
Procalcitonin (PCT)

- 116-amino acid peptide
- C-cell in the thyroid
- Healthy subject <0.1ng/mL

During microbial infection
  - Increase CALC-I expression
  - Release of PCT from all parenchymal tissues

PCT for sepsis and infection

- Smart biomarker:
  - High specificity (97%) and sensitivity (78%)
  - Readily measurable
  - Affordable and available in many hospital
  - Reproducible
  - Half-life of 24 hours

Studies so far

- PCT reduces unnecessary antibiotic (AB) usage & decreases the duration of therapy\(^1\)
- PCT-guided strategy reduced AB use by 41.6% for acute respiratory infection defined by symptoms only in primary care\(^2\)
- PCT can predict bacterial infection as a cause of pneumonia in patients with a low PSI (I-II)\(^3\)
- PCT has proven to be a good prognostic marker in patients with high PSI (III-V)\(^4\)

A Prospective Randomised Single Blinded Study in consecutive patients presenting to St George Hospital with CAP

- Hypothesis: that the addition of PCT guidance can reduce hospital admission and length of stay for patients with CAP
- Recruitment completed, n=56
**PCT-driven protocol**

**PCT** = Procalcitonin (ng/mL)  
**Switch** = early switch to oral AB guideline  
**IVAB** = intravenous AB  
**D/C** = discharge from CAP point of view  
**AB** = antibiotics

1. **PCT** < 0.15
   - **Stop AB**
   - **D/C**
   - **Stay 2º to other reasons**

2. **PCT** 0.15-0.24
   - **Switch**
   - **D/C**
   - **Stay 2º to other reasons**

3. **PCT** 0.25-0.5
   - **IVAB**
   - **Repeat PCT level**

4. **PCT** > 0.5
   - **IVAB**
   - **Repeat PCT level**

**Clinical Judgment**

- **D/C** with oral AB if not already done so
- **Switch** if already on oral AB
- **IVAB unless already on oral AB**

**D4+**

**Legend**

- **Y** = Yes
- **N** = No

---

**Notes**

- **D1**
- **D2**
- **D3**
- **D4+**

---

**Abbreviations**

- **PCT**
- **Switch**
- **IVAB**
- **D/C**
- **AB**

---

**Explanation**

- **PCT** levels are categorized into four ranges:
  - **PCT** < 0.15: Stop antibiotics.
  - **PCT** 0.15-0.24: Switch to oral antibiotics.
  - **PCT** 0.25-0.5: Initiate intravenous antibiotics.
  - **PCT** > 0.5: Continue intravenous antibiotics.

- **Switch** to oral antibiotics is recommended if the patient meets specific criteria.

- **D/C** indicates discharge from the CAP point of view.

- **Clinical judgment** is used when PCT levels transition to levels that signify a need for changes in treatment.

---

**Conclusion**

The PCT-driven protocol aims to guide the appropriate use of antibiotics based on PCT levels, ensuring timely adjustments in treatment as PCT levels change.
Summary

- The complexity of scoring systems vary
  - Effect on compliance
- Scoring systems can predict:
  - Pneumonia severity
  - Risk of mortality
  - Risk of ICU and high dependency care
  - Safety for outpatient management
MILD CAP

- Amoxycillin 1 gram tds for 5-7 days +/- Doxycycline or Clarithromycin depending on the clinical suspicion of an atypical pathogen
- Cefuroxime 500mg bd an alternative to Amoxycillin in a case of minor penicillin HS
- Moxifloxacin 400mg daily with major penicillin allergy
MODERATE SEVERITY CAP

- Those patients requiring admission: Benzylpenicillin 1.2g 6-hourly or Ampicillin 1.0g 6-hourly plus Doxycycline or Clarithromycin

- Those patients with Penicillin Allergy:
  - Use intravenous Ceftriaxone or Cefotaxime
SEVERE CAP

- Ceftriaxone/Cefotaxime IV plus Azithromycin 500mg IV daily
- Those with major Penicillin allergy then replace the cephalosporin with Moxifloxacin 400mg IV
Exceptions to consider:

- Patients who have risk factors for more resistant bacteria
- Those with underlying lung disease eg. Bronchiectasis
- Those patients on antibiotics preceding presentation
- Those patients with associated pleural effusions, empyema?