ePneumonia

Real-time clinical decision support for ED patients with community-onset pneumonia

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First recommendation
IDSA-ATS 2007 community-acquired pneumonia guidelines

“Locally adapted guidelines should be implemented to improve process of care variables and relevant clinical outcomes”

(Strong recommendation; level I evidence.)
Clin Infect Dis 2007; 44:S27–72
Why computerized decision support for emergency department pneumonia patients?

- More than 70% of hospitalized pneumonia patients are admitted through the ED
- ED is the site of initial diagnosis and triage
- Most data needed for decision making is in the electronic medical record
- Superior to paper based and order set decision support
Why computerized decision support for emergency department pneumonia patients?

- Gathers data needed to support decision making
- Calculates severity of illness and risk for antibiotic resistance
  - Recommends most appropriate antibiotic and site of care
- Open loop
  - Allows for clinical judgment
Key Elements of Pneumonia Process of Care in the Emergency Department

- Diagnosis
- Admission decision support
- Identification of risk factors for resistant pathogens
  - HCAP is mostly dead
  - Expanded group of risk factors - DRIP
- Obtaining appropriate cultures - blood/sputum/tracheal aspirate, nasal swab for MRSA
- ED administration of antibiotics tailored to severity of disease and likely pathogens
- Recognition and initial treatment for sepsis/respiratory failure/ARDS
Impact of an Electronic Clinical Decision Support Tool for Emergency Department Patients With Pneumonia

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Results: The study population comprised 4,758 ED pneumonia patients; 14% had health care–associated pneumonia. Median age was 58 years, 53% were female patients, and 59% were admitted to the hospital. Physicians applied the tool for 62.6% of intervention ED study patients. There was no difference overall in severity-adjusted mortality between intervention and usual care EDs post–tool deployment (odds ratio [OR]=0.69; 95% confidence interval [CI] 0.41 to 1.16). Post hoc analysis showed that patients with community-acquired pneumonia experienced significantly lower mortality (OR=0.53; 95% CI 0.28 to 0.99), whereas mortality was unchanged among patients with health care–associated pneumonia (OR=1.12; 95% CI 0.45 to 2.8). Patient disposition from the ED postdeployment adhered more to tool recommendations.
Odds ratios for mortality associated with implementation of ePneumonia clinical decision support.

O.R. = 1.12
P = .81

O.R. = 0.53
P = .045

Mixed effect logistic regression model adjusted for eCURB, presence of pleural effusion, gender, and PaO2/FiO2 ratio.
ePneumonia version 2.0 for iCentra

- Antibiotic allergy logic
- Coordinated with electronic order sets
- Link to ED and hospital admission note
- Summary output into electronic record
- Integrated real-time with ED process of care
- Alerts for probable pneumonia patients
- Minimal additional input from clinicians, user friendly
- Accesses longitudinal iCentra EMR for data
Accurate diagnosis of pneumonia

- Pneumonia a clinical syndrome without a gold standard except for positive microbiology
- Accuracy of emergency department pneumonia diagnosis versus expert panel review only 62.0% to 75.9%

Kanwar CHEST 2007; 131:1865
Welker Arch Intern Med 2008; 168(4):351
Bayesian network diagram of pneumonia likelihood. Effect on pneumonia likelihood is reflected by the size of box.

Dean  JAMA IM 2013 173(8):699
Accuracy of pneumonia diagnosis with ePneumonia plus physician judgment

- 1835 consecutive patients where ePneumonia utilized, 7 Wasatch Front Intermountain Healthcare emergency department during 2012

- Random sample of 100 patients reviewed by 2 pulmonary/ccm physicians
  - 4 patients final ED physician diagnosis not pneumonia
  - 96 patients diagnosed with pneumonia, all but 8 confirmed on review
  - Accuracy of diagnosis = 92%
LaunchPoint alerts providers that a patient may have pneumonia. When the probability for pneumonia reaches a 40% threshold, 2 separate indicators show on the patient’s row. The first is a green “P” icon:

The second is an alert in the Physician Notifications column.

ePneumonia is launched from the Care Pathways component on the ED Workflow page. ePneumonia will open as a new tab in the workflow view.
Pneumonia found via Natural Language Processing of the radiology report? Y N

Pneumonia found via radiology report

Do you acknowledge the ePneumonia protocol?

Yes - Pneumonia is present - Enroll patient in protocol

Save

Recommended Treatment Options

The ePneumonia Care Process Model is intended for immunocompetent patients > 18 years with pneumonia acquired outside the hospital.

When necessary, answer questions on the left while following recommendations on the right. When possible, answers will be automatically defaulted based on data available.

Please click on ePneumonia below to finish enrolling and begin.

ePneumonia

Document Off Pathway
To Admit or Not to Admit?  
An important question…

- Costs are 20 times higher in hospitalized patients\(^1\)
- Less ill patients return to work and usual activities faster if treated at home\(^2\)
- Patients hospitalized after initial outpatient treatment have higher mortality\(^3\)
- Severely ill patients not initially admitted to ICU have higher mortality\(^4\)

1) Niederman Clinical Therapeutics 20:820-837, 1998
2) Labarere Chest 131:480 2007
4) Neill Thorax 51:1010 1996
Admission Rates by ED Physician  Dean Annals EM 2012

% Patients Admitted

79% 38%
CURB-65

- Score 1 point each for:
  - Confusion
  - BUN > 20
  - Respiratory rate > 30/min
  - BP (systolic BP <90 mmHg or diastolic BP <60 mmHg)
  - Age > 65 years

- Scoring
  1. Home treatment OK
  2. Ward admission or observation
  3+. Hospital admission
  ?Assess for ICU

Computerized Pneumonia Risk Assessment Using Electronic Medical Records (eCURB) Predicts Mortality More Accurately than CURB-65

B. Jones *Chest* 2011; 140;156-163

**Sensitivity**

**Specificity**

- **eCURB** (AUC = 0.87)
- **Binary CURB-65** (AUC = 0.82)
Rule for Emergency Department Disposition
ePneumonia

• Admit to Intensive Care Unit     Any one of:
  - Severe CAP ≥ 3 factors
  - PaO2/FiO2 ratio < 120 mm Hg

• Admit to Hospital     Any one of:
  - PaO2/FiO2 ratio < 280 mm Hg
    ✤ Calculated from SpO2 and delivered oxygen if no ABG
  - Electronic CURB predicted mortality ≥ 5%
  - Parapneumonic effusion ≥ small

Dean  Annals Emerg Med  2012
Jones  BMC Pulmonary Medicine 2014, 14:149
Dean  Annals Emerg Med  2015
Severe Hypoxemia? (PaO2/FiO2 Ratio <= 120 mmHg)  
Y  
N  
PaO2/FiO2 Ratio: 137 mmHg

How many of the following Severe CAP Criteria exist?  
More than 3  

Vitals  
Age: 65 Years  
Confusion (patient not oriented to person, place, or time): No  
Temperature (<= 36 C): 36 C  
Respiratory Rate (>= 30 BPM): 30 BPM  
Systolic Blood Pressure (< 90 mmHg): 105 mmHg  

Labs  
BUN (>=20): 30  
WBC (< 4 K/mcL): 10 K/mcL  
Platelet Count (< 100 K/mcL): No Data Found  
PaO2/FiO2 Ratio (<=213): 137 mmHg  

Radiology  
Infiltrates (Multilobar): No Data Found  

ICU Admission is recommended. This patient has Severe Pneumonia based on 81% likelihood of needing ICU treatment and 4 Severe CAP Criteria.

Do you agree with ICU Admission Recommendation?  
Agree with Recommendation  
Disagree with Recommendation  

Save
Pneumococcal resistance

- Ceftriaxone, ampicillin/amoxicillin, and levofloxacin remain highly active
- Macrolide resistance among adults
  - Strep. Pneumoniae last 5 yrs
    - 21% Logan/Cache Valley
    - 36% Wasatch Front
Outpatient Antibiotic Therapy
No antibiotic last 3 months, no comorbidities

- Doxycycline monohydrate 100 mg bid for 7 days
  - Sun sensitivity, Epigastric pain/Nausea, Category D pregnancy
- Amoxicillin 1 gm PO tid for 7 days
# Treatment Options

**Recommended Treatment Options**

Outpatient Treatment and Pneumonia are confirmed.

When necessary, answer questions on the left while following recommendations on the right. When possible, answers will be automatically defaulted based on data available.

**The following orders are recommended for the patient.** The ePneumonia Care Process Model has been completed. Please save before exiting.

- **ED ePneumonia Outpatient Mild**

[Order button]

[Document Off Pathway button]
Empiric Inpatient Therapy

**DRIP <4**

- **Ward patients**
  - Ceftriaxone 1 gm daily plus doxycycline 100 mg bid PO, or azithromycin 500mg IV/PO daily for 3 days
  - Levofloxacin 750 mg IV/PO daily for 5 days

- **ICU patients**
  - Ceftriaxone 1 gm IV q 12 plus intravenous azithromycin 500 mg IV daily for 3 days
HCAP is (mostly) dead

- Outcomes in patients with HCAP worse when treated with HCAP guideline–concordant regimes compared to CAP therapy
  - OR for mortality 2.18, 95% CI 1.86-2.55\(^1\)
  - Survival to 28 days 65% in the compliance group and 79% in the non-compliance group (p=0.004)\(^2\)

1) Attridge Eur Respir J 2011, 38:878

5-year Trends in Initial Antibiotic Use

- Azithromycin %
- Ceftriaxone %
- Resp Fluoroquinolones %
- Vancomycin %
- Pip/Tazo %
- Cefepime %
- Cefepime %
- Linezolid %
<table>
<thead>
<tr>
<th>Condition</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotic use &lt;60 d</td>
<td>2</td>
</tr>
<tr>
<td>Long term care</td>
<td>2</td>
</tr>
<tr>
<td>Tube feeding</td>
<td>2</td>
</tr>
<tr>
<td>Prior CAP-DRP (1 yr)</td>
<td>2</td>
</tr>
<tr>
<td>Hospitalization &lt;60 d</td>
<td>1</td>
</tr>
<tr>
<td>Chronic pulmonary disease</td>
<td>1</td>
</tr>
<tr>
<td>Poor functional status</td>
<td>1</td>
</tr>
<tr>
<td>Gastric acid suppression</td>
<td>1</td>
</tr>
<tr>
<td>Wound care</td>
<td>1</td>
</tr>
<tr>
<td>MRSA colonization (1 yr)</td>
<td>1</td>
</tr>
</tbody>
</table>

Validation cohort, Utah, AZ, Connecticut

<table>
<thead>
<tr>
<th>Test</th>
<th>Cut-off Score</th>
<th>Sens %</th>
<th>Spec %</th>
<th>PPV %</th>
<th>NPV %</th>
<th>AUROC (95% CI)</th>
<th>Inadequate Spectrum %</th>
<th>Overall Accuracy %</th>
<th>Unnecessary spectrum %</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRIP</td>
<td>4</td>
<td>0.79</td>
<td>0.84</td>
<td>0.63</td>
<td>0.92</td>
<td>0.874 (0.799-0.950)</td>
<td>5.5</td>
<td>82.7</td>
<td>11.8</td>
</tr>
<tr>
<td>HCAP</td>
<td>1</td>
<td>0.76</td>
<td>0.71</td>
<td>0.48</td>
<td>0.89</td>
<td>0.735 (0.635-0.835)</td>
<td>6.3</td>
<td>72.4</td>
<td>21.3</td>
</tr>
</tbody>
</table>
DRIP score 4 or greater and all ICU admitted community-acquired pneumonia patients

- Blood, sputum, tracheal aspirate, pleural fluid cultures
- Urinary antigens for pneumococcus and legionella
- Nasal swab for MRSA
  - Negative predictive value for MRSA pneumonia >95% published, 100% LDSH/IMC
- Change from Vancomycin and Cefepime to Ceftriaxone within 48 hours for patients without a resistant organism identified
## DRIP implementation study

Salt Lake Valley Hospitals 11/2014 to 10/2015

<table>
<thead>
<tr>
<th>DRIP versus Usual Care</th>
<th>DRIP, %</th>
<th>Usual Care, %</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate Spectrum</td>
<td>0.67</td>
<td>0.93</td>
<td>NS</td>
</tr>
<tr>
<td>Overtreatment</td>
<td>20.6</td>
<td>27.8</td>
<td>0.008</td>
</tr>
<tr>
<td>Appropriate Spectrum</td>
<td>78.6</td>
<td>71.0</td>
<td>0.005</td>
</tr>
</tbody>
</table>

B Webb, European Respiratory Society 2016
DRIP implementation study
Salt Lake Valley Emergency Departments – 11 months

• Odds of in-hospital mortality
  – ePneumonia with DRIP (odds ratio 0.64; upper 95% confidence interval 1.04; \( p = 0.06 \))

• Decreased length of hospital stay
  – ePneumonia with DRIP (coeff – 0.147; upper 95% CI – 0.137; \( p < 0.001 \)).

### Treatment Assessment

Please verify and update risk factors for Drug Resistant Pathogens that may influence drug recommendations below:

<table>
<thead>
<tr>
<th>Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Ambulatory</td>
</tr>
<tr>
<td>Use of Antibiotics within the last 7 to 60 days</td>
</tr>
<tr>
<td>Hospitalization &gt;= 2 days within 60 days</td>
</tr>
<tr>
<td>Gastric Tube - current encounter</td>
</tr>
<tr>
<td>Gastric Acid Suppression in last 14 days</td>
</tr>
<tr>
<td>Nursing Home Resident</td>
</tr>
<tr>
<td>Chronic Pulmonary Disease</td>
</tr>
<tr>
<td>Antibiotic Resistant Organism within last 12 months</td>
</tr>
<tr>
<td>Active Wound Care</td>
</tr>
<tr>
<td>Positive MRSA Culture within last 12 months</td>
</tr>
<tr>
<td>None</td>
</tr>
</tbody>
</table>

### Treatment Options

**Recommended Treatment Options**

Inpatient - ICU Admission and Severe Pneumonia are confirmed.

When necessary, answer questions on the left while following recommendations on the right. When possible, answers will be automatically defaulted based on data available.

**The following orders are recommended for the patient.** The ePneumonia Care Process Model as been completed. Please save before exiting.

- ED ePneumonia DRP ICU Admission

**Order**

**Document Off Pathway**
ePneumonia version 2.0 for iCentra

- Development began February 2017
- Beta-test rollout May 2017 Central Region ED’s
- Rapid cycle improvement process
  - Various “glitches” have been identified and fixed
  - Overall still “clunky”, not easy to use with current interface
  - Stepwise release of “M pages”, other fixes pending
- ePneumonia was standard care for ED pneumonia patients Intermountain Central Region since 2011
  - Use has dropped off since iCentra deployed
ePneumonia

- Stepwise, 6 cluster deployment trial planned across 16 Intermountain adult hospital ED’s
- $458 K grant from Intermountain’s Office of Research
- AHRQ 261 grant $1.2 million being submitted
- Awaiting updates in ePneumonia program
  - Rollout at McKay-Dee October 2nd
ePneumonia iCentra for Instacare deployment

- Will apply for a second AHRQ grant $800K over 2 years
- Stepwise, group randomized, deployment trial into 31 Intermountain Instacares
- Study outcomes:
  - Disposition home vs ED vs hospital ward vs ICU
  - Antibiotic prescribing, CXR ordering
  - Direct cost of care, time to return to usual activities, fatigue and cough
  - Percent tool use by provider, provider attitudes survey
Conclusions

- **ePneumonia (legacy EMR)**
  - More accurate diagnosis of pneumonia
  - More appropriate disposition from ED and antibiotic prescribing
  - Lower mortality

- **While awaiting deployment of ePneumonia/iCentra**
  - Use paper Pneumonia CPM
  - iCentra order sets
  - Use DRIP calculator on Intermountain.net