Best Practice Model for Imaging of Community Acquired Pneumonia

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Objectives:

- Review the importance of a chest x-ray in the diagnosis of pneumonia
- Describe the key components of a radiology report in the diagnosis of pneumonia
- Discuss the new approaches to communicate the key finds on a chest x-ray to the
Healthcare is changing – how does that affect radiology?
Radiology exists to answer a clinical question
Our reports and our images are our work products
Our reports must change
- Searchable
- Integrated
- Actionable
Computerized Clinical Decision Support

- Use validated models for patient care to help guide decision making
- Decision support for many processes, ranging from simple alerts to aids in complex decision making
- Radiology reports must be able to be integrated into these tools
The CAP Protocol

• CAP is serious problem
  – 12th leading cause of death
  – Most common cause of death from infection
  – 1.7 million hospitalizations in US each year
• ED is the critical site for pneumonia care

Within the ED
• Initial diagnosis
• Triage decision - SCAP
• Identification of risk factors for specific pathogens (e.g. MRSA, Pseudomonas, health care associated pna)
• Initiation of antibiotics
• Recognition and initial treatment for severe sepsis
The CAP Protocol

- Probabilistic model based on Bayesian network technology
- Uses 40 clinical variables to evaluate likelihood of pneumonia.
- Developed from a database of 50,462 LDS Hospital ED patients which included 2,568 confirmed pneumonia patients

Clinical data utilized

- 6 vital sign variables
- 6 laboratory values
- 25 variables from the nursing assessment
- Patient age, the chief complaint
- Findings extracted from the chest radiographic report using natural language processing
The CAP Protocol

- **Chest Imaging**
- **Chief Complaint**
- **Vital Signs**
  - Temperature
  - Heart Rate
  - Respiratory Rate
  - Blood Pressure
  - SpO2
  - Age
- **Labs**
  - WBC
  - Chloride
  - Creatinine
  - Blood urea nitrogen
- **Nurse Assessment**

**PNEUMONIA**
The CAP Protocol

- Radiographic evaluation (CXR and any Chest CT) is the most important element in diagnosing pneumonia.

- Tool runs only when the patient's dictated radiographic report becomes available.

- Natural Language Processing program looks for words and phrases in dictated reports that indicate pneumonia.

Key Clinical Questions From Radiology Reports

- Is there a new parenchymal opacity that could be consistent with pneumonia?

- Is it unilobar or multilobar?

- Is there an associated pleural effusion?

- Is there cavitation?
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Pneumonia Likelihood: **92%**

Acknowledged Date/Time: **9/30/2011 3:04:27 PM**

- **Acknowledgement**
  - Yes - Pneumonia is Present - Enroll patient in protocol
  - OR
  - No - Pneumonia is Not Present

- **Vitals**
  - Temperature: 37.5°C
  - Systolic Blood Pressure: 102 mm/Hg
  - Diastolic Blood Pressure: 54 mm/Hg
  - SpO2: 81%
  - Heart Rate: 99 BPM
  - Mean Blood Pressure: 70 mm/Hg
  - Respiratory Rate: 26 BPM
  - Chief Complaint: RESPIRATORY_COMPLAINT

- **Labs**
  - Chloride: 95.0 mmol/L
  - BUN: 21.0 mg/dL
  - Sodium: 135.0 mmol/L
  - Creatinine: 1.3 mg/dL
  - WBC: 29300 cells/mm3

- **Chest Exam/Radiology Finding**
  - BS_CLEAR: Yes
  - NLP Finding: Positive
Hospital Ward Admission recommended. The patient has Moderate CAP based on no HCAP factors, a 30 day mortality risk of 8.2%, and a 33% likelihood of needing ICU treatment, based on 2 Severe CAP criteria.

Health Care Acquired Pneumonia Factors
A single positive HCAP factor means the patient has HCAP.
- **Hospitalization >= 2 days**
  - Yes
  - No
- **Nursing Home Resident**
  - Yes
  - No
- **Wound Care or Infusion Therapy within 30 days**
  - Yes
  - No
- **Chronic Dialysis within 30 days**
  - Yes
  - No

Vital Factors
- **Age**: 78 Years
- **Confusion (patient not oriented to person, place, or time)**
  - Yes
  - No
- **Temperature**: 37.5°C
- **Respiratory Rate**: 26 BPM
- **Systolic Blood Pressure**: 102 mm/Hg

Labs
- **BUN**: 21 mg/dL
- **WBC**: 29300 cells/mm³
- **Platelet Count**: 268000 cells/mm³
- **PaO₂/FiO₂ Ratio**: 252.3 mm/Hg

Radiology
- **Pleural Effusion**: Yes
- **Infiltrates**: Single Lobe

Save Changes
The CAP Protocol

- Implementation of this guideline within Intermountain facilities decreased 30-day all cause mortality with a result of **25 lives saved each year**.

- Well accepted and appreciated by ED physicians.

- Yet it could be better......
The Problem

Review of hundreds of chest x ray reports

- Four physicians (3 pulmonary, 1 ED resident) disagreed (yes, maybe, no for presence of pneumonia) in 15% of readings.
- NLP disagrees with physician reviewers 20% of time.
- NLP misinterpretation of reports accounts for 59% of false positive alerts.
Chest x ray Reporting in CAP
Applying the Value Chain Model

- Define the clinical context
- What are the key clinical questions that clinicians need to know?
- What are the standards for appropriate imaging utilization?
- What exam/s should be used to answer these clinical questions?
- What will be the standard imaging protocol for these exams?
- How will the interpretation become standardized?
- What specific reference material will be required to assist in interpretation?
- What will the structured report look like?
- How will results be communicated?
Define the clinical context

- Important, as CXR is nearly half of all radiologic exams
- Chest x rays are non-specific, clinical information is KEY
- Signs and symptoms of CAP are vague, clinician accuracy low
- ED patients presenting with typical signs and symptoms of CAP
- ED patients who are not presenting with typical signs and symptoms of CAP, but in whom CAP is present
- Define top 10 associated s/s and any presenting s/s with r/o PNA as added history by ED physician
What are the key clinical questions clinicians need to know?

- Is there a new parenchymal opacity that, in the appropriate clinical setting, could represent pneumonia?
  
  **IF YES or MAYBE...**
  
  - Is it unilobar or multilobar?
  - Is there a pleural effusion?
  - Is there cavitation?
What are the standards for appropriate imaging utilization in this clinical context?

• “In addition to a constellation of suggestive clinical features, a demonstrable infiltrate by chest radiograph or other imaging technique, with or without supporting microbiological data, is required for the diagnosis of pneumonia.” IDSA/ATS 2007 guidelines

• Data show that the clinical exam alone is insufficient for the diagnosis of pneumonia
What exams should be used to answer these clinical questions?

- **2 View chest x-ray** should be standard
  - In one study, 22% of missed pna’s by radiology residents were visible in one view only
  - Can more accurately determine if is multilobar or unilobar
  - Can more accurately assess if there is associated pleural fluid
    - Small and medium effusions are either missed or misdiagnosed 45-55% of the time on beside x-ray
What exams should be used to answer these clinical questions?

• “CT scans may be more sensitive, but the clinical significance of these findings when findings of radiography are negative is unclear” *IDSA/ATS 2007 guidelines*

• **CT helpful** in immunocompromised patients with normal cxr and in patients in whom complications (empyema, lung abscess, cavitation) or neoplasm are suspected

• Will work with ED and CPOE to establish standards for ordering
What will the standardized protocol be for these exams?

- Standard 2 view chest x-ray
- Plan to standardize all CT protocols eventually
How will we help standardize interpretation?

- Pneumonia can present with wide range of imaging findings.
Findings reflect underlying pathophysiology and pathway of spread

1. Pulmonary vasculature
2. Direct spread of infection
3. Tracheobronchial tree
Findings reflect underlying pathophysiology and pathway of spread

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- Typical lobar pneumonia
- Lobular or bronchopneumonia
- Interstitial pneumonia
Chest x ray Reporting in CAP
Standardizing Interpretation

Lobar Pneumonia
Typical of pneumococcal pneumonia
Lobular or bronchopneumonia
Typical of staph pneumonia and multiple other etiologies
Interstitial Pneumonia
Typical of mycoplasma or viral pneumonias
Chest x ray Reporting in CAP
Standardizing Interpretation

- Patterns typical of organisms but there is considerable overlap

- Cannot reliably distinguish between viral and bacterial pneumonia on chest x ray alone
Chest x ray Reporting in CAP
Standardizing Interpretation

- Invite expert guest speakers
- Work with subspecialty leads to standardize terminology and improve uniformity of interpretation
Chest x ray Reporting in CAP
Applying the Value Chain Model

What specific reference material will be required to assist in interpretation?
Two options for communicating answers to the key questions....

- With specific, defined text within our reports
- As a discrete data elements within RW.net
EXAM:

COMPARISON:

CLINICAL INFORMATION:

FINDINGS:

Cardiomediastinal Silhouette - [Normal]

Lungs - [Normal]

Opacity Compatible With Pneumonia - [No] [Yes or Possibly (Answer ONLY with yes/no/possibly, and, if yes or possibly, include whether multilobar or cavitory in impression.)]

Pleural Space - [No pleural fluid or pneumothorax].

Osseous Structures and Soft Tissues - [Normal] [Degenerative changes of the spine but otherwise normal] [_______]

Additional Findings - [None]

IMPRESSION:

[No acute cardiopulmonary process.] [Normal chest x ray.] [_______]
EXAM:

COMPARISON:

CLINICAL INFORMATION:

FINDINGS:

Cardiomedastinal Silhouette - [Normal]

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Pleural Space - [No pleural fluid or pneumothorax].

Osseous Structures and Soft Tissues - [Normal] [Degenerative changes of the spine but otherwise normal] [________]

Additional Findings - [None]

IMPRESSION:

[No acute cardiopulmonary process ] [Normal chest x ray ] [______]
Chest x ray Reporting in CAP
Structured Report
Chest x-ray Reporting in CAP
Structured Report

New focal opacity c/w pna in the appropriate clinical setting?
- Yes
- No
- Possibly
Chest x ray Reporting in CAP
Applying the Value Chain Model

Communication standards – what is critical finding?

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• Healthcare is changing – radiology reports must change to allow for integration into computerized decision support tools.
• Chest exams are critical to the diagnosis of CAP yet findings are variable and non specific.
• To overcome this challenge, we must incorporate a discrete searchable answer to the clinical question into our reports.
Chest x ray Reporting in Community Acquired Pneumonia

Questions?
Chest x ray Reporting in Community Acquired Pneumonia

References


