Empyema: An Uncommon Complication of Common Pneumonia

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Overview

• Patient presentation
  – History of present illness and other relevant information
  – Menu of appropriate radiologic tests and their indications
  – Review of lung anatomy on chest x-ray
  – Overview of our patient’s radiographic findings
  – Differential diagnosis
• A complication of the diagnosis
  – Definition and epidemiology
  – Appearance on imaging
  – Companion patient images
  – Management overview
• Update on our patient’s clinical course
• Summary
Our Patient: History of Present Illness at First Presentation

- **CC:** left-sided chest/shoulder pain and dyspnea

- **HPI:** 70-year-old woman presents with 2 days of increasing, constant, non-radiating left-sided chest and shoulder pain and 1 day of increasing dyspnea and productive cough.

- **PMH:** type 2 DM, HTN, hypothyroid, chronic pain, hyperlipidemia, breast CA (1989, s/p mastectomy), thyroid CA (2005, s/p thyroidectomy and I-125)
Our Patient: First Presentation
Vital Signs, Physical Exam, and Labs

- **Vitals:** T 99.6, HR 127, BP 134/70, RR 16, O_2 sat 98% RA

- **Physical Exam:** crackles in left lung base, pain with movement of left shoulder

- **Labs:** WBC 13 (90% PMNs)
At this point, acute respiratory illness is a likely etiology for our patient’s presentation.

However, the differential diagnosis remains broad.

We will now consider the use of imaging to narrow this differential.
Menu of Radiologic Tests for Adults with Acute Respiratory Illness

- Chest X-ray (CXR)
- CT chest
Indications for Imaging in Adults with Acute Respiratory Illness: Chest X-Ray

- **Chest X-ray**
  - Indicated for evaluation of acute respiratory illness in patients with the following characteristics:
    - Age >40 years
    - Hemoptysis
    - Dementia
    - Comorbidities (e.g., CAD, CHF, etc.)
    - Associated abnormalities (e.g., hypoxia, leukocytosis)
    - Clinical suspicion of pneumonia

- **Chest CT**

Indications for Imaging in Adults with Acute Respiratory Illness: Chest CT

• Chest X-ray
• Chest CT
  – Indicated for evaluation of:
    • Abnormalities seen on plain x-ray
    • Recurrent or persistent pneumonia
    • Suspected pleural abnormality
    • Suspected lung abscess
    • Pulmonary embolism
    • Airway patency
    • Guidance for thoracentesis when u/s is not sufficient
  – Depending on the goal of the study, it may be performed with and/or without contrast

www.acr.org; Mandell, et al., Clin Infect Dis 2007
Given this menu of potential tests, their indications, and our patient’s clinical presentation, a chest x-ray was obtained.

Before we examine our patient’s current chest x-ray, we will review some basic anatomy using prior films.
Review of Lung Anatomy on CXR

Our patient: Prior PA CXR

Prior lateral CXR
Anatomy Review: Right Lung Fissures

Prior PA CXR

Prior lateral CXR

Minor fissure

Right major fissure
Anatomy Review: Right Upper Lobe

Prior PA CXR

Prior lateral CXR
Anatomy Review: Right Middle Lobe

Prior PA CXR

"Silhouette sign": On the PA film, an opacity in the right middle lobe may obscure the right heart border (….)

Prior lateral CXR

BIDMC, PACS
Anatomy Review: Right Lower Lobe

Prior PA CXR

“Silhouette sign”: On a PA film, an opacity in the RLL may obscure the right hemidiaphragm ().

Prior lateral CXR

“Spine sign”: On lateral, a RLL opacity may interrupt the normal progressive increase in lucency of the thoracic vertebral bodies (★).
Anatomy Review: Left Major Fissure

Prior PA CXR

Prior lateral CXR
Anatomy Review: Left Upper Lobe

"Silhouette sign": On the PA film, an opacity in the lingular portion of the left upper lobe may obscure the left heart border (•••)
Anatomy Review: Left Lower Lobe

Prior PA CXR

“Silhouette sign”: On the PA film, an opacity in the left lower lobe may obscure the left hemidiaphragm (••••)

Prior lateral CXR

“Spine sign”: On lateral, a LLL opacity may interrupt the normal progressive increase in lucency of the thoracic vertebral bodies (★)
Our Patient: Prior PA and Lateral CXR

Prior PA CXR

Prior lateral CXR

Please pause to review our patient’s prior films and give your general impression.
Our Patient: Prior CXR Findings

General impression: Normal chest X-ray, note the absence of the left breast shadow (★) s/p mastectomy
Now back to our patient’s current presentation with left-sided chest pain and dyspnea…

ECG is unchanged from prior.

A portable AP chest X-ray is obtained.
Our Patient: Current AP CXR

First admission AP CXR  Prior PA CXR

Please pause to compare our patient’s new CXR with the prior film.

Reminder - Systematic Approach to CXR:
- Acknowledge major abnormalities
- Quality control
- Lines + hardware
- Heart + mediastinum
- Lungs + diaphragm
- Pleura
- Bones
- Soft tissues
- Checkpoints
  - Apices
  - Aortic knob
  - Hila
  - Retrocardiac regions
Our Patient: Current AP CXR Findings

Note that we are comparing a current AP CXR with a prior PA film, so changes in heart size cannot be adequately assessed.

**Opacity in left mid + lower lung fields** with air bronchograms, partially obscuring L hemidiaphragm

Small **left pleural effusion** (↑) obscuring costophrenic angle

**Absence of left breast shadow** (★) s/p mastectomy

Given these findings, what is the differential diagnosis?
Our Patient:
Differential Diagnosis at First Presentation

- Pneumonia
- Malignancy
  - Primary
  - Metastasis
- Pleural effusion
  - Parapneumonic
  - Malignant
- Atelectasis
Given our patient’s clinical presentation and CXR findings, she is diagnosed with a left lower lobe community-acquired pneumonia, admitted to the hospital, and started on levofloxacin.

Over the next two days, her white blood cell count, dyspnea, cough, and chest pain improve and she is discharged.
Our Patient: Second Presentation

After discharge, our patient returns home.

The next morning, she presents again with severe, pleuritic, left-sided chest pain.

She is afebrile, tachycardic, and tachypneic.

Another chest X-ray is obtained.
Our Patient: 
CXR at Second Presentation

Please pause to compare our patient’s current CXR with the film from her prior admission.
Our Patient: Findings from CXR at Second Presentation

New Findings:
More prominent opacity in left mid and lower lung fields, silhouetting out the left heart border and hemidiaphragm.

The left costophrenic angle (↑) is obscured.

Spine sign (↑)

Quality control:
Mediastinum appears wide (↔) due to the patient’s rotated position.
Poor arm positioning (★) obscures upper lung fields.
Our Patient: Differential Diagnosis at Second Presentation

- Inadequately treated pneumonia
- Complicated pneumonia
  - Simple parapneumonic effusion
  - Complicated parapneumonic effusion
  - Empyema
  - Necrotizing pneumonia
- Lung collapse/atelectasis
- Mucus plug
- Lung malignancy
- Malignant effusion
- Pulmonary embolism

Given this differential diagnosis, what should the next step be? Do we need further imaging?
Based on the findings from the chest X-ray and the patient’s worsening clinical condition, the decision is made to order a CTA to rule out pulmonary embolus and further characterize the abnormalities seen on CXR.
Our Patient: Chest CTA from Second Presentation

Cross-sectional views, C+ Chest CT, soft tissue window

Not depicted: Contrast opacification of pulmonary arteries is complete to segmental level and the central airways are patent.

Please pause to evaluate the images.
Our Patient: Chest CTA Findings

Left lower lobe collapse with worsening consolidation (★)

Non-hemorrhagic pleural effusion (★), with pleural fluid measuring ~27 Hounsfield units

Septation within pleural effusion (↑) and non-dependent layering (★) indicating loculation

Reminder re: Hounsfield units (HU):
Air: -1000 HU
Fat: -30 HU
Water: 0 HU
Soft tissue: +30 HU
Blood: +40 HU
Bone: +1000 HU
Our Patient: Revised Differential Diagnosis Following Chest CTA

- Complicated pneumonia
  - Simple parapneumonic effusion
  - Complicated parapneumonic effusion
  - Empyema
- Lung collapse/atelectasis
- Lung malignancy
- Malignant effusion
Based on the findings from the chest CTA and the patient’s clinical presentation, she is diagnosed with a probable empyema and transferred to the ICU for further management.
Empyema: Definition, Phases, and Epidemiology

- **Definition:** The presence of pus and/or gram stain/culture-positive fluid in the pleural space
- **Three phases:**
  - Exudative: inflammation of visceral pleura results in exudative effusion and thickening of pleural surfaces
  - Fibropurulent: inflammatory cells and neutrophils invade the pleural space, fibrin is deposited on inflamed pleural surfaces
  - Organizing: recruitment of fibroblasts and capillaries results in deposition of collagen and granulation tissue on pleural surfaces leading to pleural fibrosis
- **Epidemiology:** <2% of patients with community-acquired pneumonia develop empyema

Empyema: Appearance on Imaging

- **CXR:** may see a pleural-based opacity that has an abnormal contour or does not flow freely on lateral decubitus views
- **Ultrasonography:** may see loculated effusion
- **C+ CT chest:**
  - Classic appearance: oblong fluid collection with smooth inner margins that compresses and displaces surrounding lung and airway
  - Important to distinguish empyema from lung abscess
    - CT findings favoring abscess include a thick-walled, spherical cavity that destroys lung rather than displacing it
  - “Split pleura” sign on C+ CT:
    - Contrast-enhanced thickened visceral and parietal pleura separated by fluid
    - May be seen in the fibropurulent phase
    - Indicates exudative effusion (not specific to empyema)
  - “Pleural microbubbles”
    - Small air bubbles within fluid collection
    - May indicate resistance of the effusion to chest tube drainage

Middle-aged man with right-sided chest discomfort and shortness of breath

Cross-sectional views, C+ Chest CTA, soft tissue window

- Fluid trapped in the minor fissure (★)
- Atelectasis (→)
- Loculated right pleural effusion (★) that is layering non-dependently
- Liver dome (★)
Empyema: Management Overview

• **Thoracentesis**
  – Pleural fluid analysis, gram stain, and culture

• **Appropriate antibiotics**
  – Sterilization of empyema cavity with systemic antibiotics (minimum 4-6 weeks)

• **Drainage**
  – Tube thoracostomy
  – Video-assisted thoracoscopic surgery (VATS)
  – Open decortication
  – Open thoracostomy

Our Patient: Management of Her Clinical Course

- **Pleural fluid analysis**
  - Culture-negative, non-malignant exudative effusion with low pH and positive gram stain
  - Consistent with empyema
- **Antibiotics**
  - Broad spectrum coverage with vancomycin, cefepime, and azithromycin
- **Drainage**
  - VATS and decortication procedures were attempted without success due to difficulty ventilating the right lung during the procedures.
  - Ultimately, a chest tube was placed and the effusion drained successfully.
Our Patient: ICU Course and Outcome

• ICU course
  – Complicated by NSTEMI, serotonin syndrome, blood transfusion, and benzodiazepine withdrawal

• Outcome
  – Discharged after ~2 weeks in the ICU
  – Currently living at home and doing well
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• Update on our patient’s clinical course
Bibliography

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