RADY 401: Pneumothorax, chronic dyspnea and TB

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UNC SCHOOL OF MEDICINE Radiology

Patient history and initial workup

- Mr. H is a 61 y.o. male presenting to the ED for 3 months of persistent shortness of breath
- The dyspnea acutely worsened 12 hours prior to presentation. Patient lost approximately 10-15 pounds over the past few months. He moved to the US from Honduras 25 years ago. Never smoker.
- Vitals: BP 152/81, temp 99, **HR 142**, **RR 24**, **O2 sats 86% on room air**
- On exam → appears uncomfortable with increased work of breathing; **decreased breath sounds on the right** compared to left. No wheezing or rhonchi. Heart rate regular but tachycardic. Abdomen soft nontender. No lower extremity swelling.
- Labs: **WBCs 18.7**, RBC 4.91, **platelets 785**, troponin normal
- Patient stabilized on 2 L of oxygen and stat CXR was ordered

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List of imaging studies

- AP chest x-ray
- Chest CT scan with IV contrast

Initial Study: AP Chest X-ray

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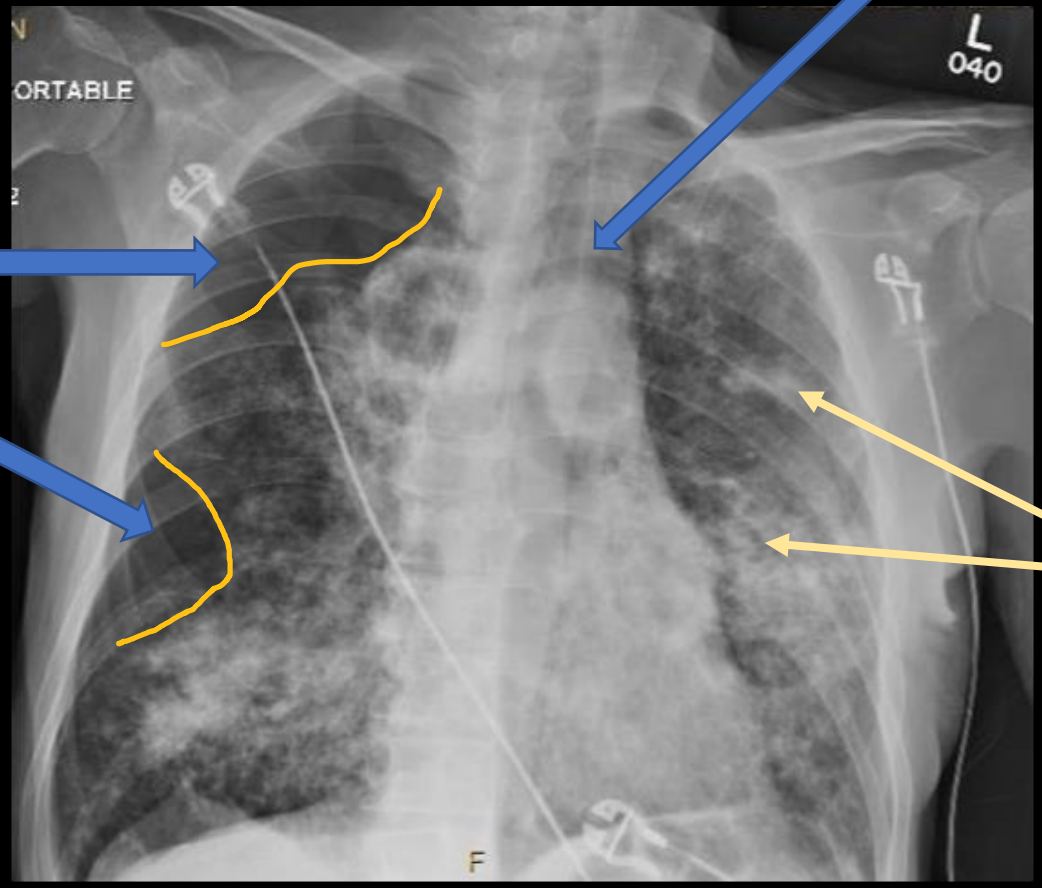
Slight leftward mediastinal shift: suggests small tension component

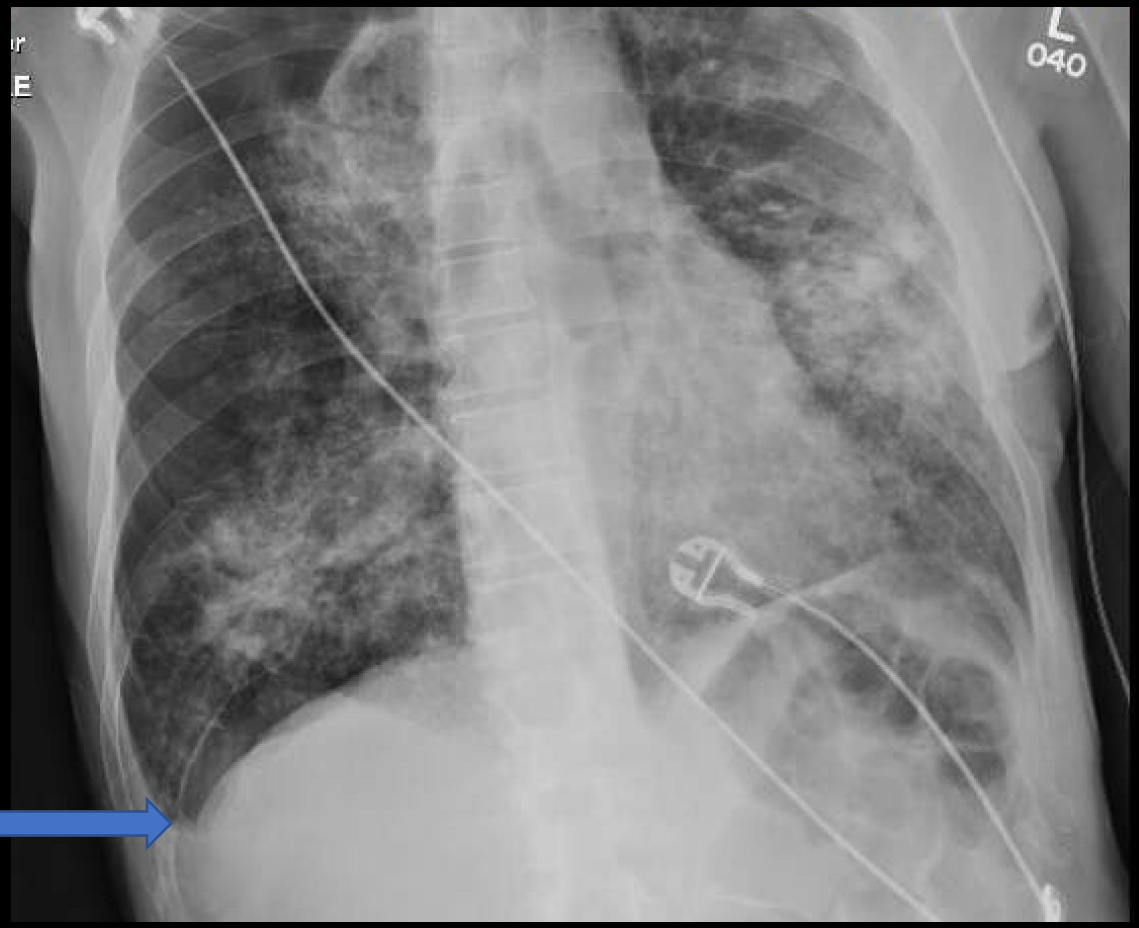


Decreased lung markings - Moderately sized right sided pneumothorax

Dense, bilateral lung opacities

Initial Study: AP Chest X-ray

- Classic findings of pneumothorax on CXR:
  - Visible visceral pleural edge seen as a sharp line
  - Beyond this line, no lung markings are seen
  - Peripheral space is usually radiolucent vs. the lung
  - If tension component, mediastinal structures will be shifted away from pneumothorax



Slight blunting of right costophrenic angle

Differential Diagnosis

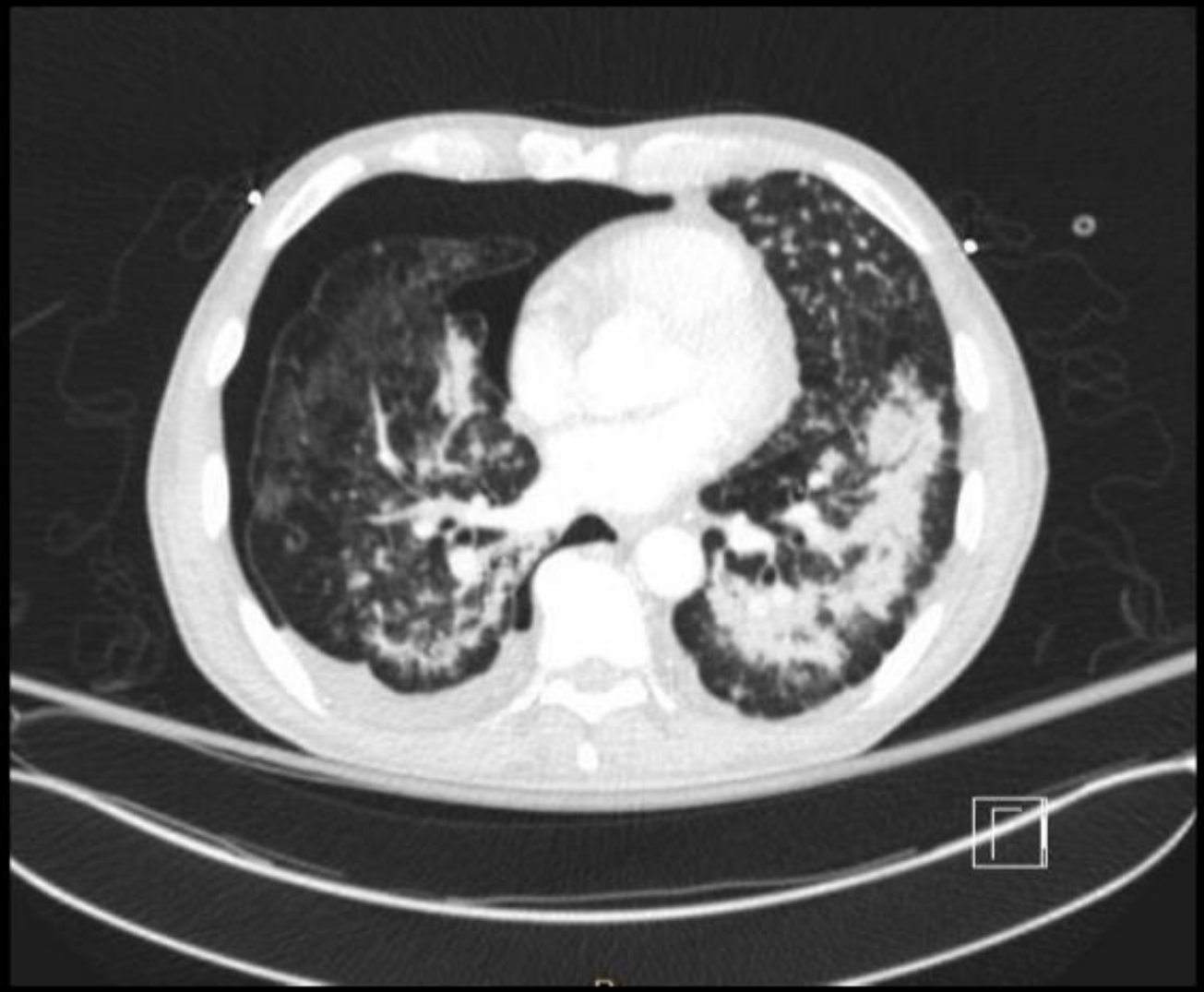
- Pulmonary tuberculosis
  - Supporting features: chronic dyspnea, weight loss, immigration from high-risk country
- Community acquired pneumonia
- Pneumocystis pneumonia (PCP)
  - Is the patient immunocompromised (e.g., HIV)?
- Atypical pneumonias (such as histoplasma)
- Malignancy

Further Workup

- AFB smear
- AFB culture
- QuantiFERON TB gold
  - Positive
- Histoplasmosis urine antigen
  - Negative
- HIV test
  - Negative

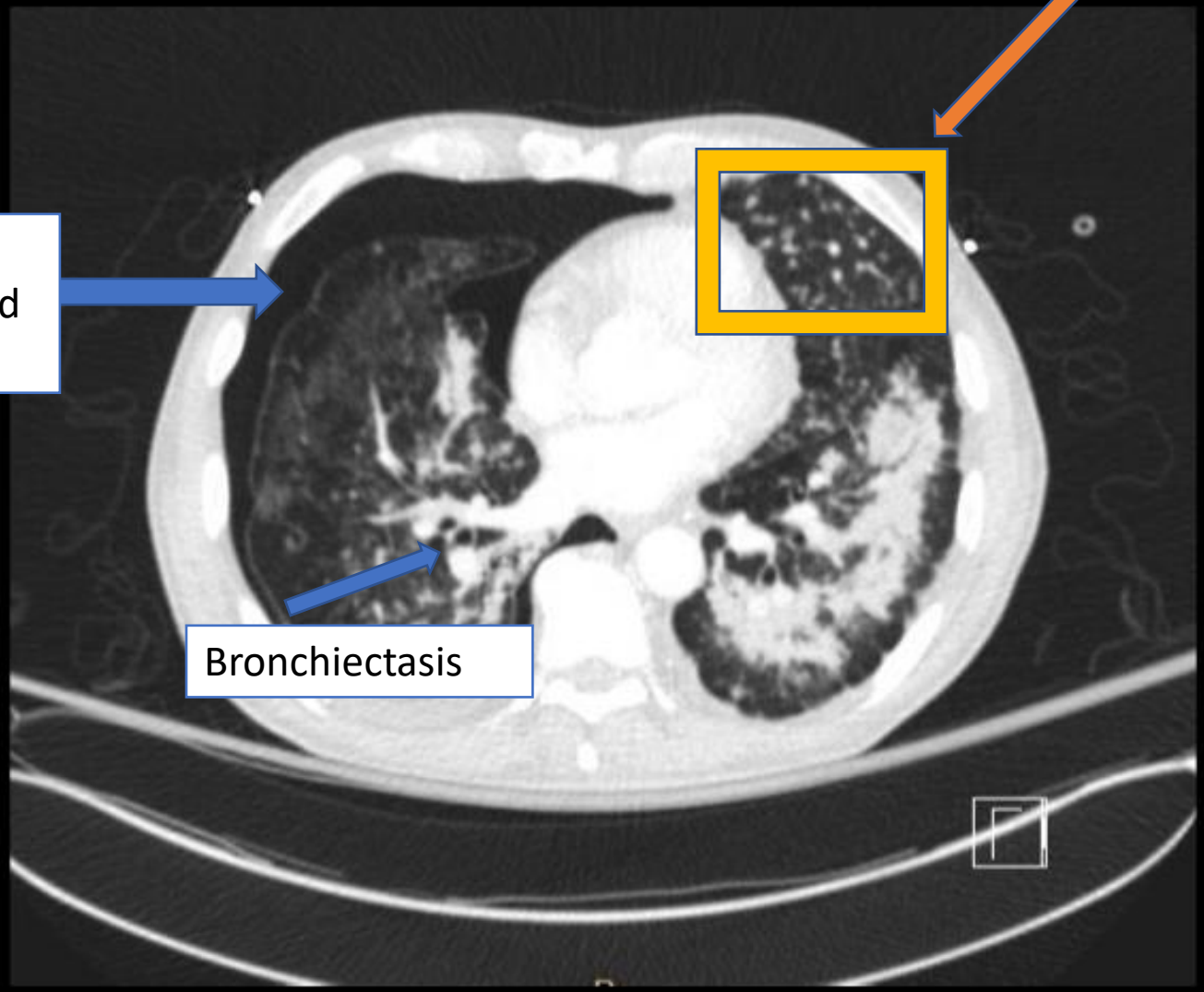
Next Study: CT Chest with IV Contrast (axial view)

- Opacities of unclear etiology on previous chest radiograph
- CT scan was ordered to further characterize these opacities and narrow the differential
- Results are shown here



Next Study: CT Chest with IV Contrast (axial view)

- Pneumothorax likely secondary to chronic fibrosis and lung disease
- Bronchiectasis (dilated bronchioles) also likely due to fibrosis

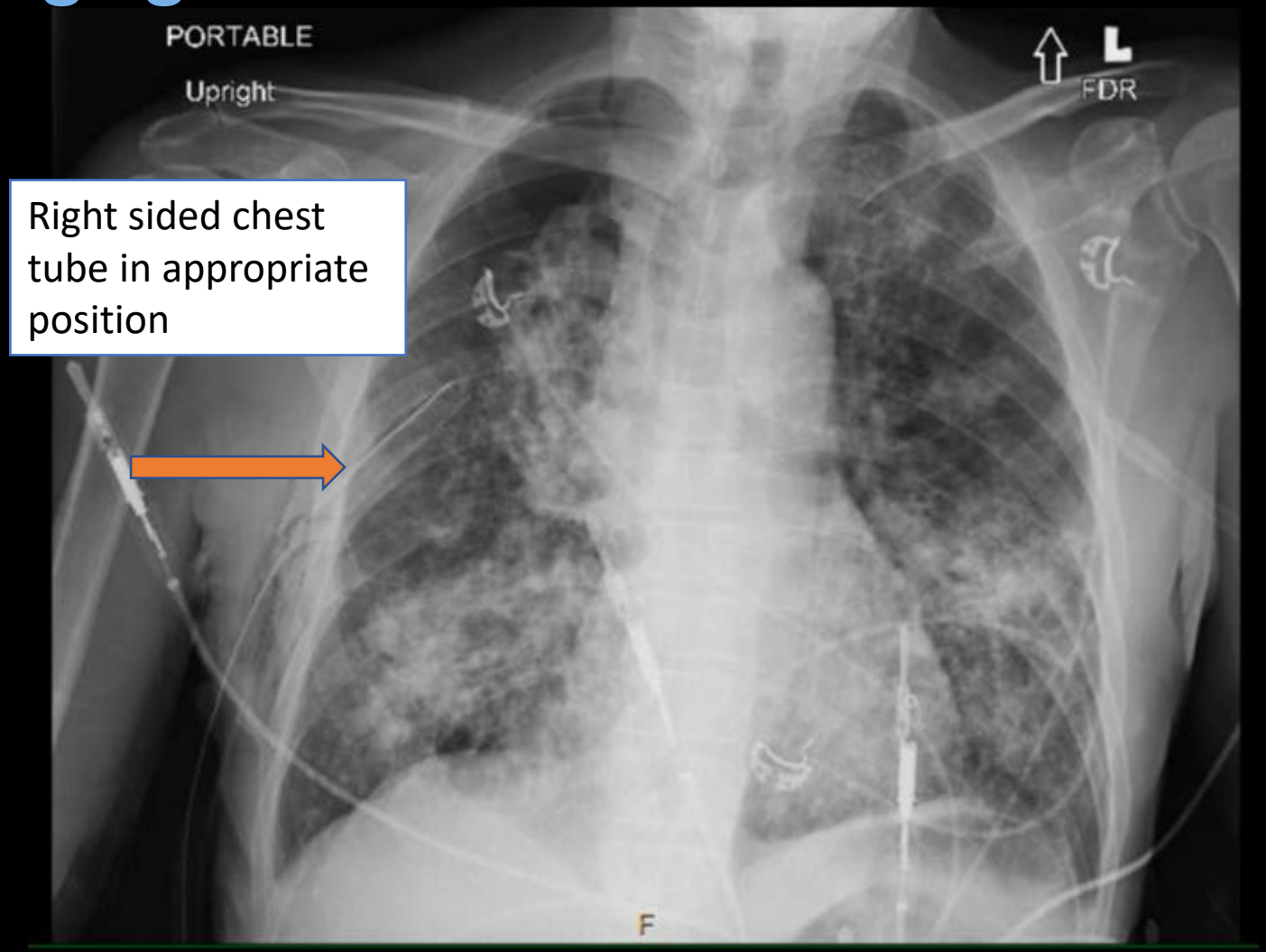


Next Study: CT Chest with IV Contrast (axial view)

- This view shows the full extent of the pneumothorax

Following initial imaging…

- Cardiothoracic surgery was quickly consulted in the ED
- A chest tube was placed in the right thorax
- Pneumothorax improved and the patient's O2 sats increased to the mid 90s on 4L O2



Patient treatment and outcome

- The patient was admitted to the MICU from the ED
- He was quickly started on empiric RIPE therapy. AFB cultures from the chest tube and sputum later resulted positive for M. tuberculosis
- QuantiFERON gold was also positive
- Pneumothorax was likely secondary to chronic fibrosis and damage from TB infection
- His respiratory status continued to worsen over the next few days. He required intubation and central line placement after developing shock on day 2 of admission
- Unfortunately, patient passed away after 4 days in the hospital
  - Official cause of death was acute on chronic respiratory failure secondary to pulmonary tuberculosis

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ACR Appropriateness Criteria: Pneumothorax

Appropriate use in our patient? YES!

Variant 2: **Acute respiratory illnesses in immunocompetent patients with positive physical examination, abnormal vital signs, organic brain disease, or other risk factors. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	☢
US chest	May Be Appropriate	O
CT chest with IV contrast	Usually Not Appropriate	☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢
CT chest without IV contrast	Usually Not Appropriate	☢☢☢
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O

Detecting Pneumothorax on CXR

- Ultrasound is more sensitive (86%) at detecting a pneumothorax than chest x-ray (53%)[1]
- Chest x-ray provides slightly higher specificity at > 99%
- Cost of a CXR typically averages $130– 300[1]
- Radiation dose is low → only 0.1 mSv (or the same amount of background radiation an average person is exposed to over 10 days) [2]

Findings	LU	CXR
Sensitivity%	86.1	52.7
Specificity%	97.4	99.4
PPV%	88.6	95.0
NPV%	96.8	90.1
DA%	95.3	90.6

Table 2: US vs. CXR for detecting pneumothorax[1]

ACR Appropriateness Criteria: TB

Appropriate use in our patient? YES!

Variant 1: **Suspect active tuberculosis.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9		☢
CT chest without IV contrast	7	This procedure is recommended if x-ray is equivocal.	☢☢☢
CT chest with IV contrast	6		☢☢☢
CT chest without and with IV contrast	3		☢☢☢
MRI chest without IV contrast	3		O
MRI chest without and with IV contrast	3		O

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level

Characteristics of CT scan for the detection of TB

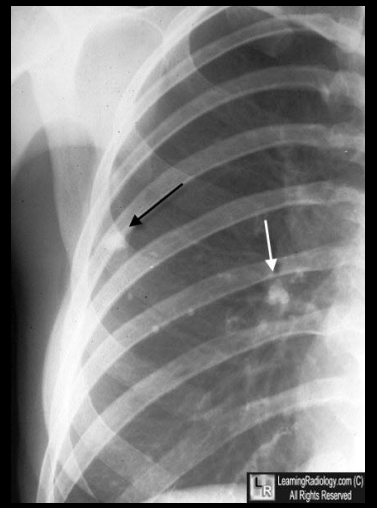
- High-resolution CT is superior to chest radiography in predicting active primary TB, with a sensitivity of 96% versus 48%[2]
- CT is also far better in terms of specificity --> 80% (even in smear-negative patients) versus 46%[2]
- Cost of a chest CT can range from $675 to $8,600[3,4] depending on the region of the country and insurance
- Typical effective radiation dose of CT chest is around 6.1 mSv[2]

Classic imaging findings in pulmonary TB

- On chest x-ray, we can sometimes see a Ghon's Complex
- This consists of a Ghon focus along with pulmonary lymphadenopathy[7]
- Over time, the lesion can undergo fibrosis and calcify to become a "Ranke Complex" as seen below

Example of a Ghon's Complex[5]

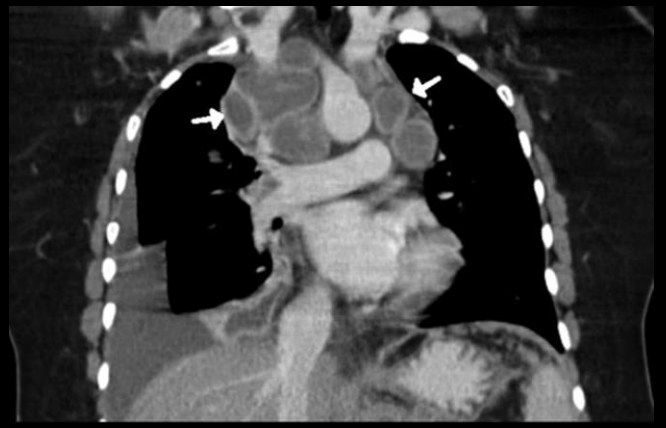
After progression



Example of a Ranke Complex[6]

Classic imaging findings in pulmonary TB (cont.)

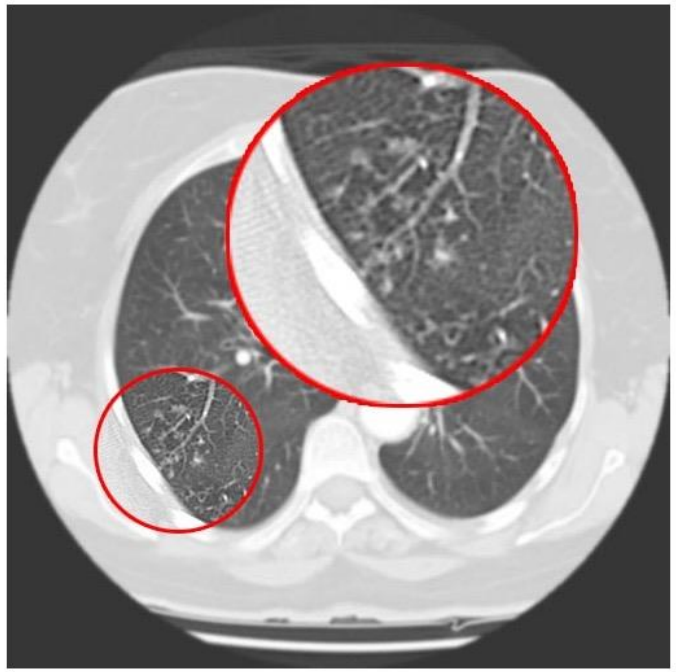
- Other imaging findings include the following:
  - Pleural effusions
  - Miliary disease spread
  - Lymphadenopathy (commonly of mediastinal and hilar nodes) → seen in the CT Scan here
  - Cavitation
  - Tree-in-bud opacities (see next slide)

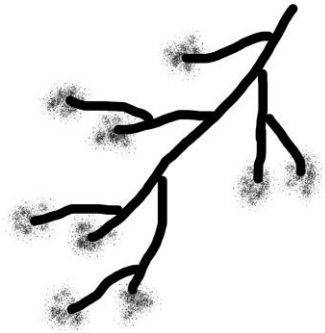


Example of large mediastinal lymphadenopathy in TB[7]

Tree-in-Bud Opacities

- A CT pattern consisting of centrilobular nodules with linear branching[8,9]
- Histological correlate is granulomatous inflammation with necrosis[8]
- Can indicate obstruction in distal airways → bronchioles are filled with inflammatory exudate
- Differential can be fairly broad (bronchiolitis, CF, sarcoidosis), so clinical context is key





UNC Top Three

- 1. In a patient with acute onset dyspnea, abnormal vitals and decreased unilateral breath sounds, chest x-ray is the initial study of choice
- 2. The tree-in-bud sign on CT should raise strong suspicion for pulmonary tuberculosis in the proper clinical context. This should prompt further workup and treatment of the infection
- 3. CT is more sensitive and specific for detecting pulmonary TB than chest x-ray. If the initial radiograph is uncertain, obtain a CT for further characterization

Quiz Questions!

- 1) What radiological sign indicates a likely tension component of a pneumothorax on chest x-ray?
- 2) Which is more sensitive for detecting a pneumothorax, ultrasound or chest x-ray?
- 3) Is the tree-in-bud sign on CT specific for tuberculosis?

Quiz Answers

- 1) Mediastinal shifting = tension, deviation of structures (such as the heart and trachea) is evidence of asymmetric intrathoracic pressures
- 2) Ultrasound is more sensitive for ptx than CXR
- 3) No - tree-in-bud sign can also be seen in bronchiolitis and cystic fibrosis. It should be used in conjunction with clinical clues

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