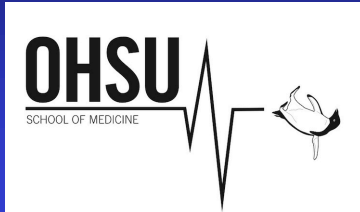


CRITICAL CARE IMAGING: What Is Not In The 'Books'

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1

Disclosures

- No relevant disclosures



2

OBJECTIVES:

- Review imaging of thoracic abnormalities in the ICU, with emphasis on chest radiographs
- Focus will be on imaging issues that are *often not conventionally taught*:
 - Abnormalities that develop *within 12-24 hours*
 - Areas *often ignored* during standard visual scan of ICU radiographs



3

Thoracic Imaging In The ICU

- Change in clinical status ("*On Demand*")
- Mechanical ventilation ("*Daily* not supported")*
- **Problem:** The *sickest* patients receive the *lowest* imaging technology

*May 2010 Radiology, 255, 386-395

The Lancet Volume 374, Issue 9702, 1687 - 1693, 14 Nov 2010



4

Cardiopulmonary Disorders That Commonly Occur Within 12 – 24 hours

- Atelectasis
- Aspiration/Retained Secretions
- Pleural Effusions/Pneumothorax
- Pulmonary edema
 - Hydrostatic (cardiogenic)
 - Permeability (non-cardiogenic)

Consider comparing with *multiple radiographs* for other possible complications



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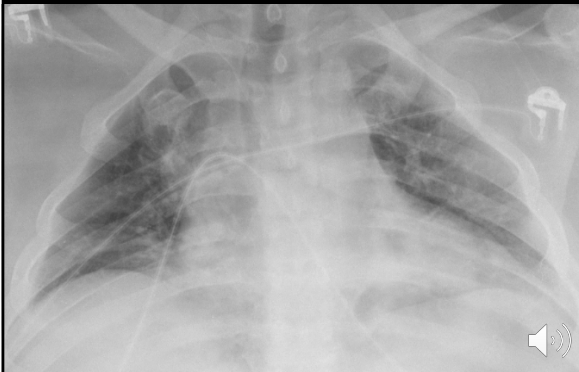
Atelectasis

- Linear, band-like and/or triangular shaped
- *Often radiating from hilum*
- Dense Hilum (Superior segmental involvement)
- Usually has smooth margins
- *Fissures are deviated*
- Lobar atelectasis - ? *Air bronchograms* (Crowded)
 - Present: Collapse of small airways
 - Absent: Central mucoid impaction



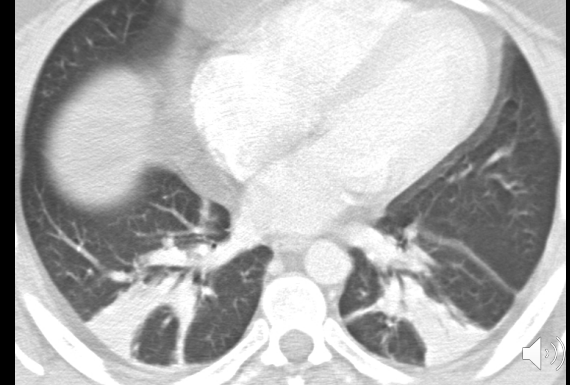
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Low Volumes, Bibasilar Linear Atelectasis



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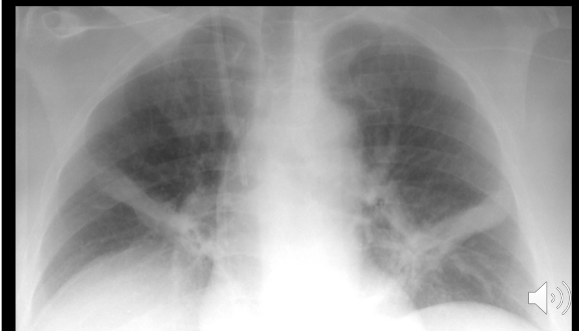
Smooth Margins, Radiate from Hilum



8

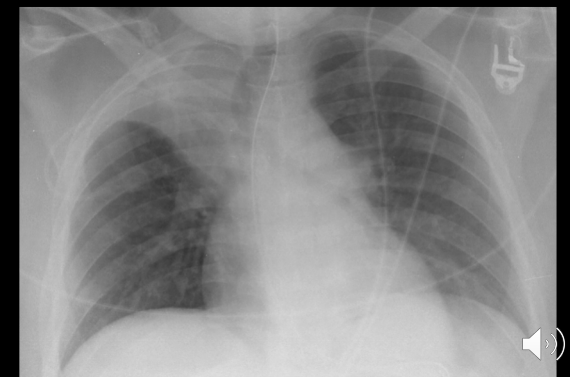
Atelectasis: **Not** A Cause of Fever

Mavros, et al "Atelectasis as a cause of postoperative fever. Where is the clinical evidence?" Chest; April 2011



9

Hypoxia, No Fever (Internal Medicine Ward)



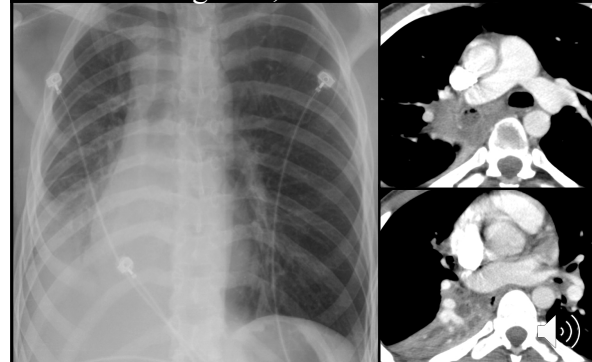
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Trauma Patient: New Onset of Hypoxia

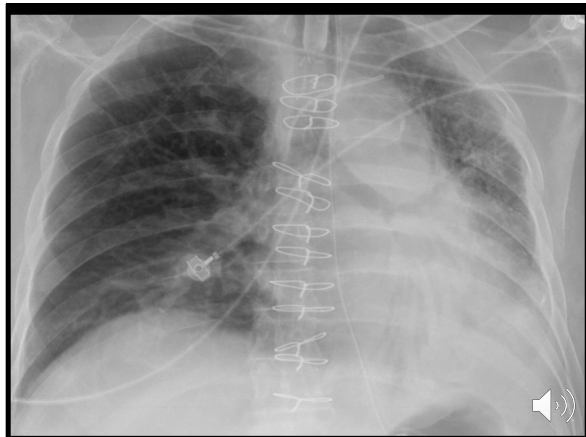


11

Right Lower Lobe Collapse: No Air
Bronchograms, Bronchial Cut Off



12



13

Aspiration/Retained Secretions Likely Cause for Low Grade Fevers

- Consolidation (Pneumonitis/Pneumonia)
- Poorly defined clustered 3-4 mm nodules
 - “Budding tree” appearance
- Airway thickening, plugging
- ‘Busy Lung’ appearance

May 2005 RadioGraphics, 25, 789-801.

14

Aspiration/Retained Secretions Location: Gravity-Based

- *Dependent portions of lung*
- Posterior upper lobes
- Superior segments of lower lobes
- Posterior basilar segments of lower lobes
- Central predominance on AP CXR –
“Dense Hilum” and “B-6 Sign”

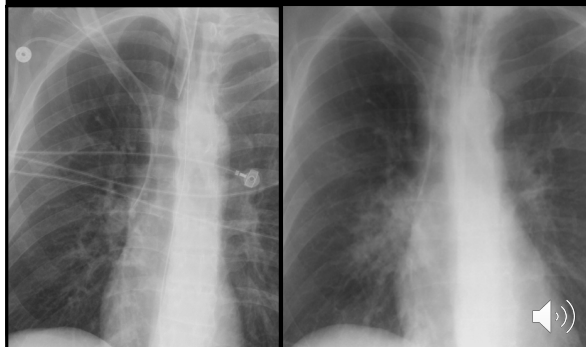
Ann Thorac Med. 2009 Jul-Sep; 4(3): 149–157.

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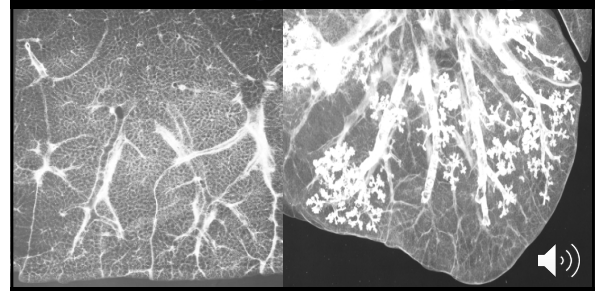
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Post Extubation: “Dense Hilum”



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Filling of Terminal Bronchial: The Budding Tree Appearance AKA - “Springtime in the Lungs”



18



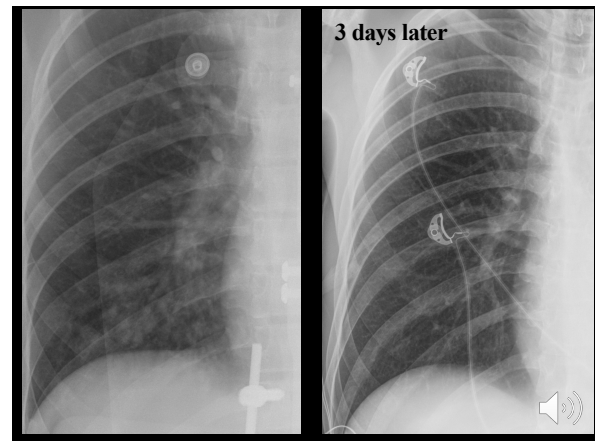
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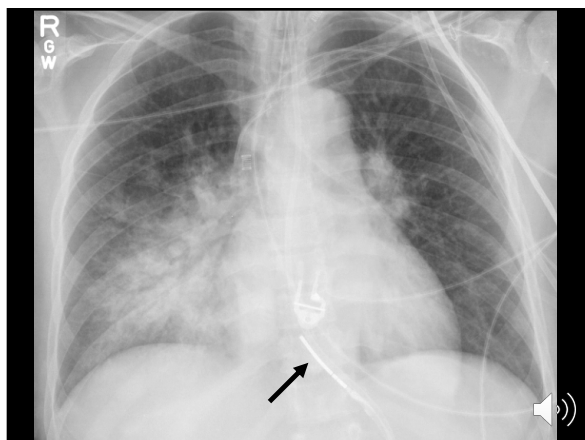
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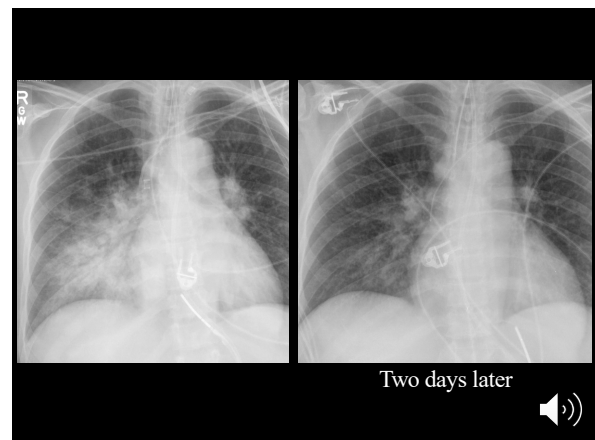
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Aspiration Pneumonia: High Fevers,
Persistent RLL Consolidation Over 1 Week



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Pneumonia in the ICU

- Most often *aerobic gram negative*
- Commonly from aspiration
- *Usually evolves over a few days*
- *Looking at prior radiographs from *more than 24 hours* is very helpful!

26

Pneumonia in the ICU

- Consolidation, *usually more Peripheral*
- Air bronchograms and ill-defined margins
- Changes occur *more slowly* than atelectasis, aspiration, pulmonary edema
- CT:
 - *Less enhancement than atelectasis*
 - Cavitation, necrosis
 - May be helpful for pleural fluid, Ultrasound preferred

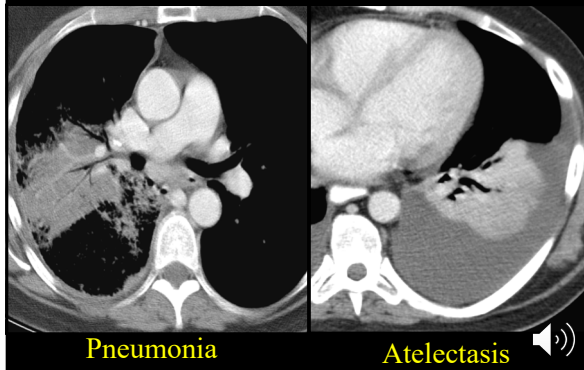
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CT Enhancement is Different

Kirsh et al - Consolidation versus atelectasis on Contrast enhanced CT scans - Presented abstract ARRS 2016



29

Pneumonia

Atelectasis

Pleural effusion

Edwards - J Comput Assist Tomogr
2016 Sept-Oct; 40(5): 746-51

30

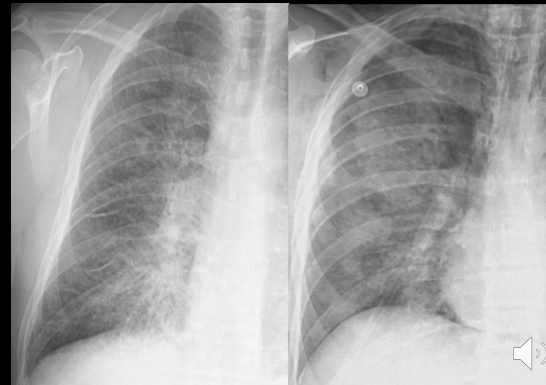
Pulmonary Edema

- **Hydrostatic:**
 - Congestive heart failure
 - Acute renal failure
- **Acute Lung Injury:** Spectrum of Non-cardiogenic – Diffuse Alveolar Damage



31

Hydrostatic Edema Non-Cardiogenic Edema



32

Hydrostatic/ Congestive Heart Failure

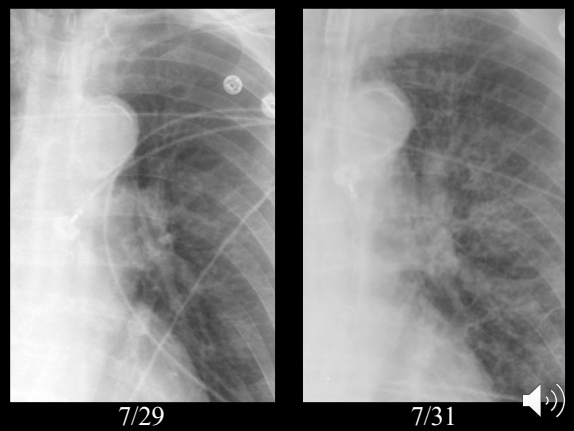
- *Vascular indistinctness*
- Interlobular septal thickening
- *Small* Pleural effusions
- Increase vascular pedicle
- Often no Endotracheal tube
- **Dependant Distribution** - Lungs are like “Towels drying on a clothes line”



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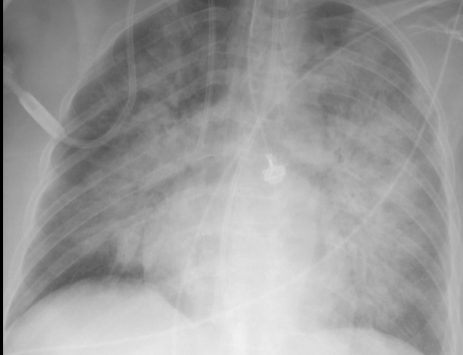
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Bone Marrow Transplant: Day 20



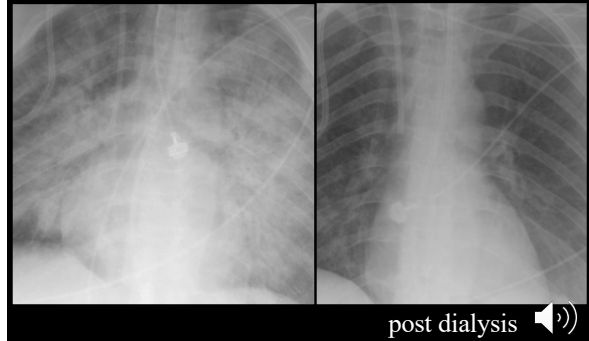
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**Acute Renal Failure: Peri-hilar
Distribution of Consolidation Does Occur**



37

**Peri-Hilar or “Bat Wing” Pattern
Characteristic For Renal Failure**

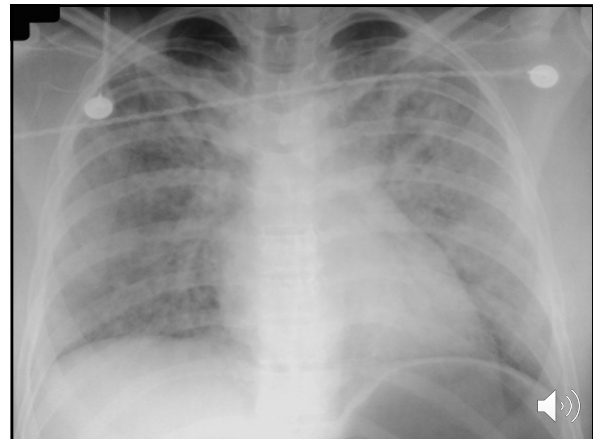


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**Acute Lung Injury:
Non-Cardiogenic Edema**

- *Spectrum of Lung injury*
- **Capillary Endothelium:** More easily injured, but *able to repair quickly*
- Results in a diffuse ground glass with hypoxia...
- *ETT often not required*, which may be a helpful clue on the radiograph

39



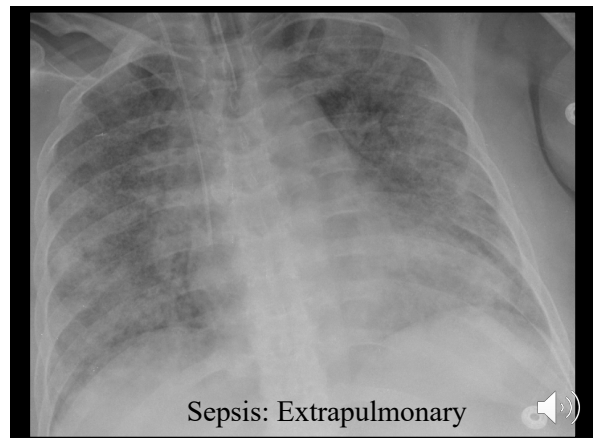
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**Acute Lung Injury:
Diffuse Alveolar Damage (ARDS)**

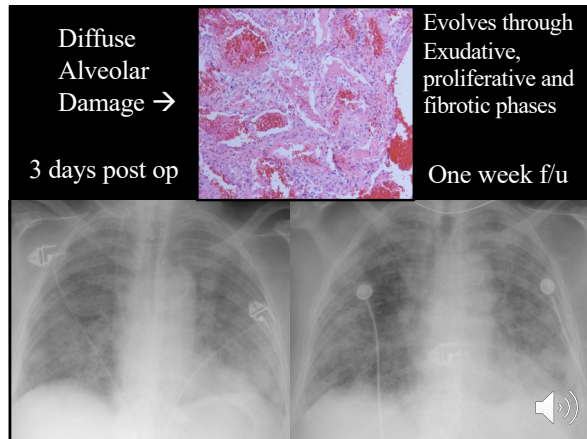
Alveolar Epithelium: More resistant to injury, but *requires much longer to repair*

- Bilateral ground-glass opacities (Vascular Indistinctness) +/- Consolidation
- Intrathoracic cause – Patchy
- Extrathoracic cause – Diffuse Distribution very common (*Systemic Injury*)
- DAD/ARDS – *ETT is Almost Always Present*

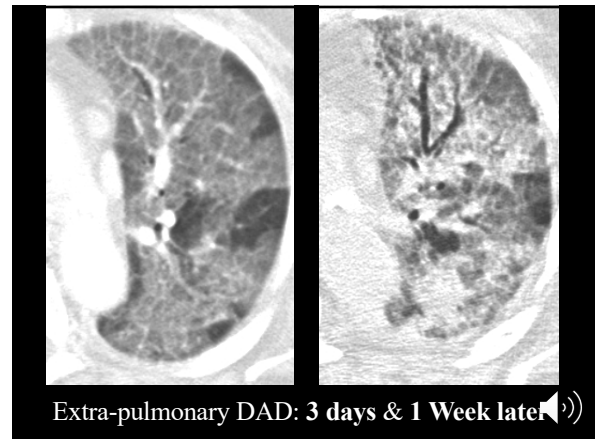
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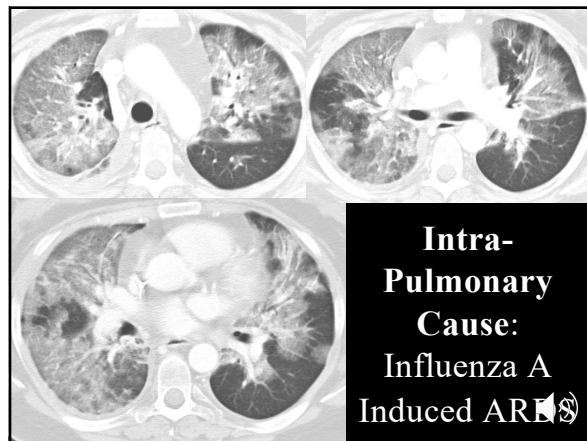
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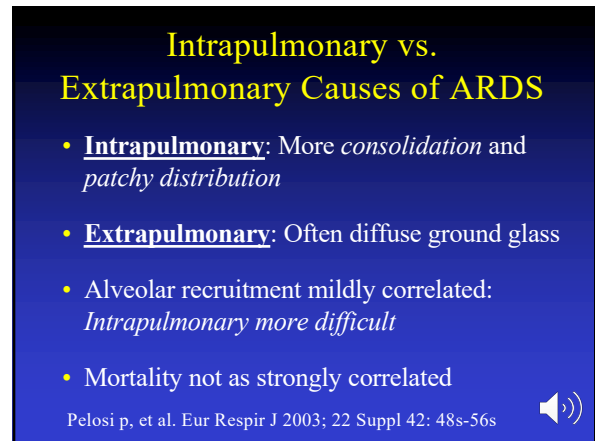
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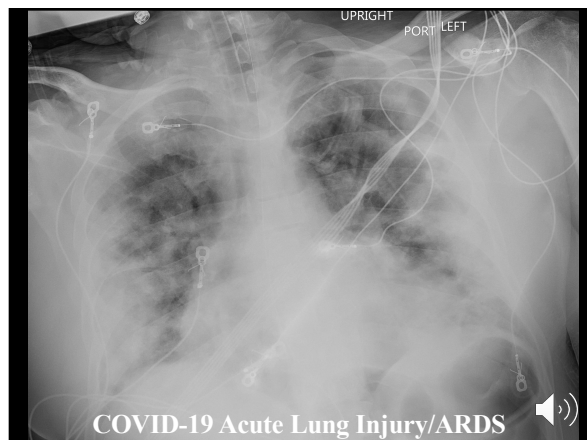
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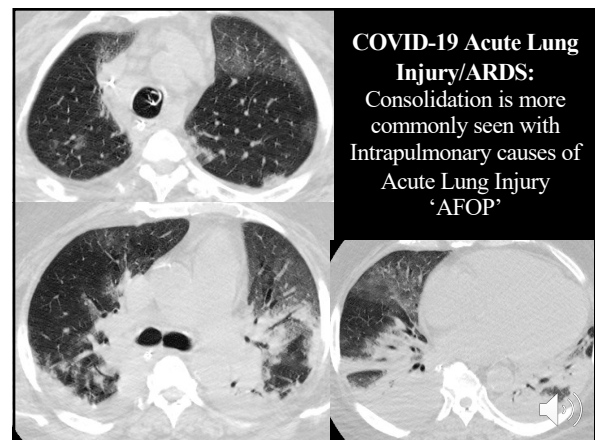
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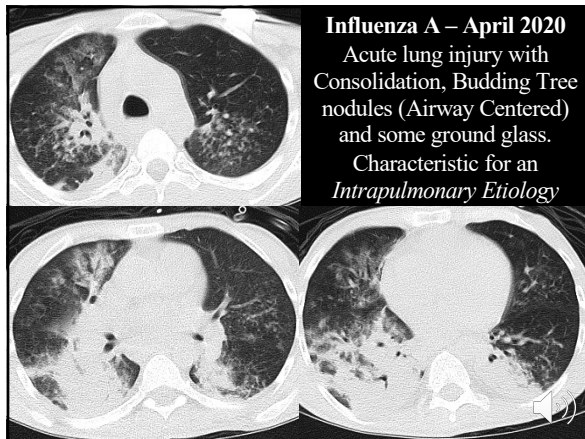
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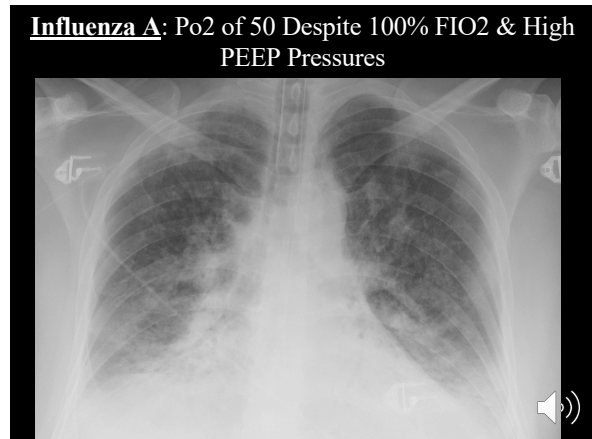
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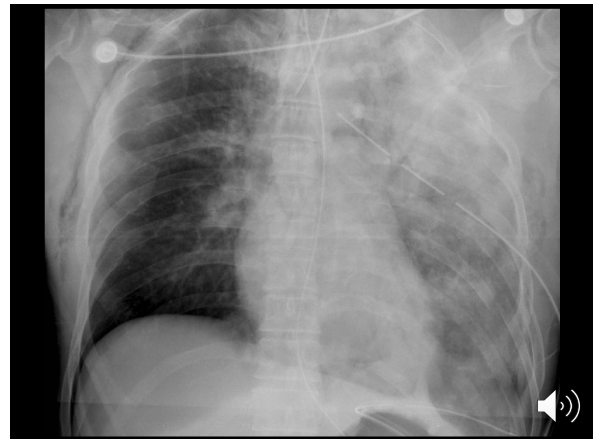


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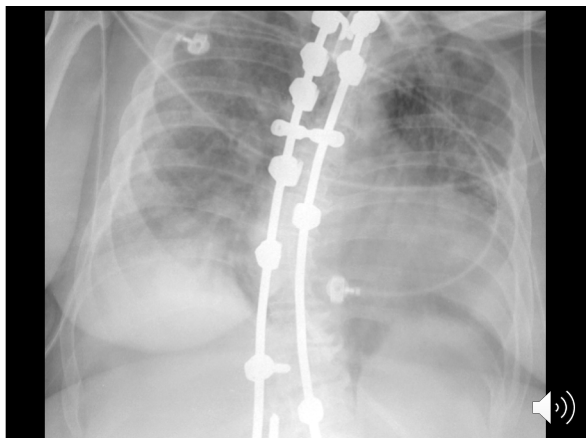
Pneumothorax

- **Thin White Line** representing visceral pleura
- Deep sulcus sign (lateral or medial)
- Cardiac fat contours rounded/lobulated
- Skin fold
 - **Edge**, not a line
 - Vascularity seen peripheral to fold
- PTX in ventilated patient: These do have *the potential* to progress to a “Tension” pneumothorax

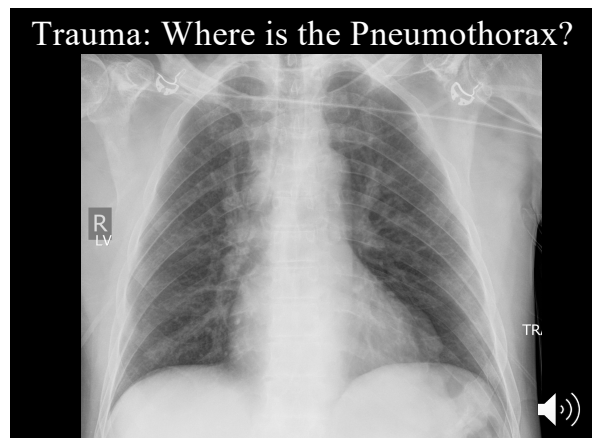
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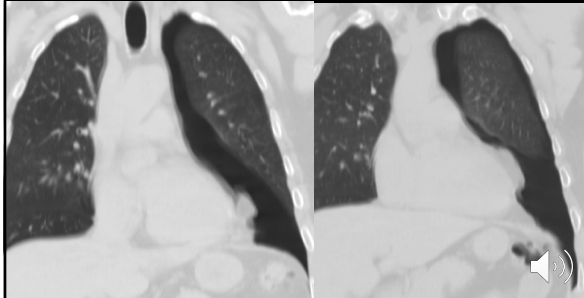


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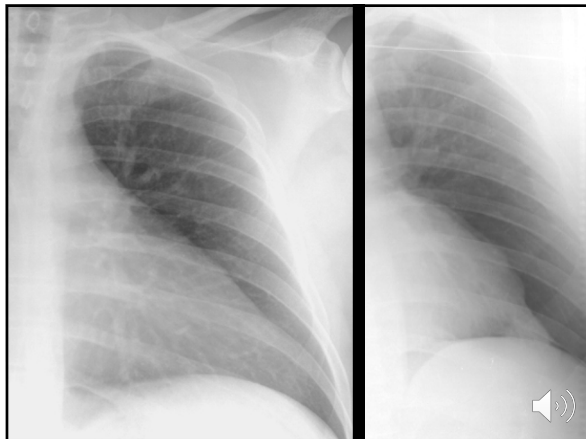
Pericardiac fat becomes *Lobulated or rounded* when the vacuum of the pleural space is compromised...



55

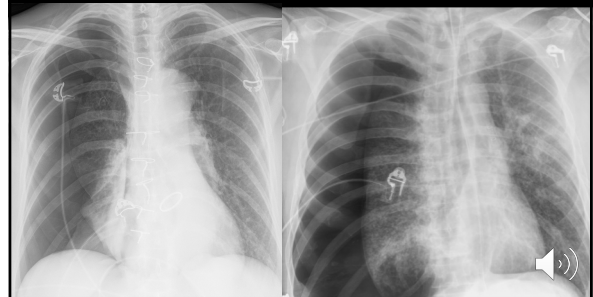


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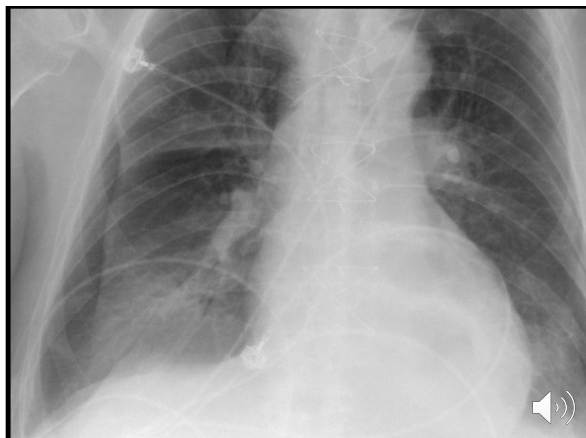


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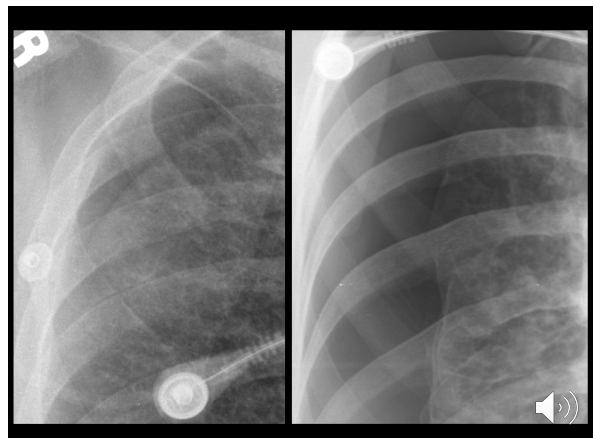
Which Radiograph Represents a Tension Pneumothorax?



58



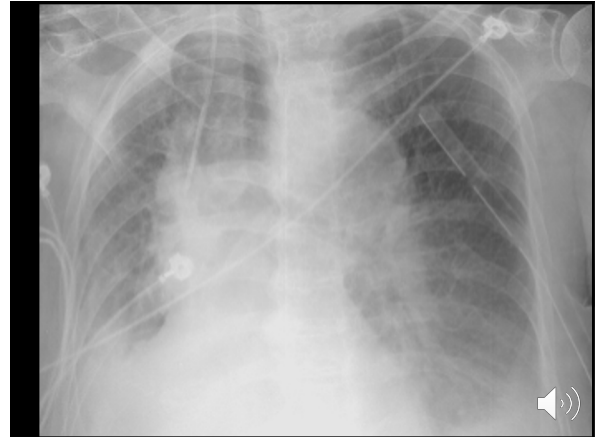
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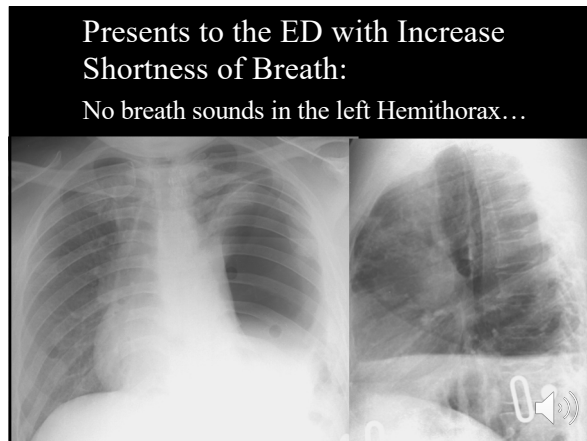
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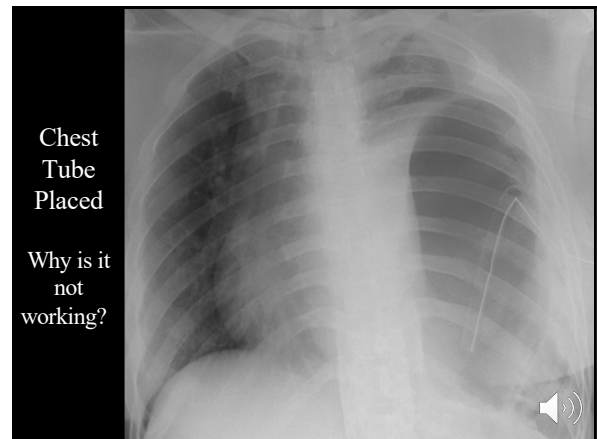
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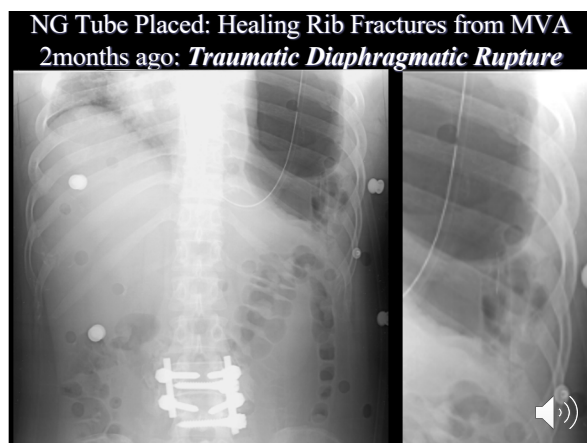
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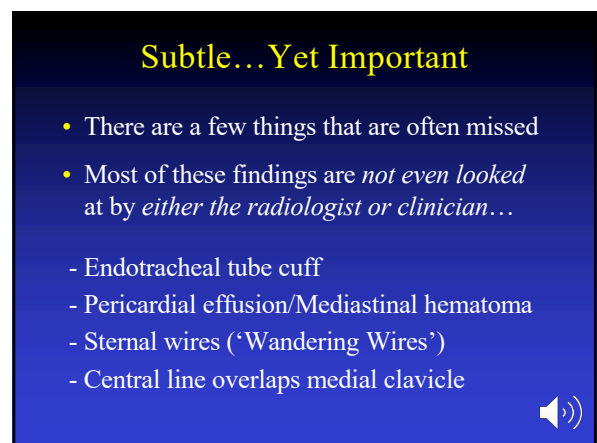
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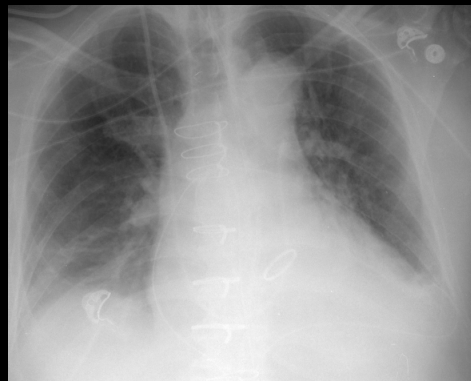
Pericardial Effusion/Anterior Mediastinal Hematoma

- Use of lines as a landmark: *Pulmonary arterial catheter, drains or Pacer leads*
- Rapid change in cardiac silhouette
- Beware of “Negative” Echo – Clotted *Blood* is very often echogenic and may be misdiagnosed or not seen



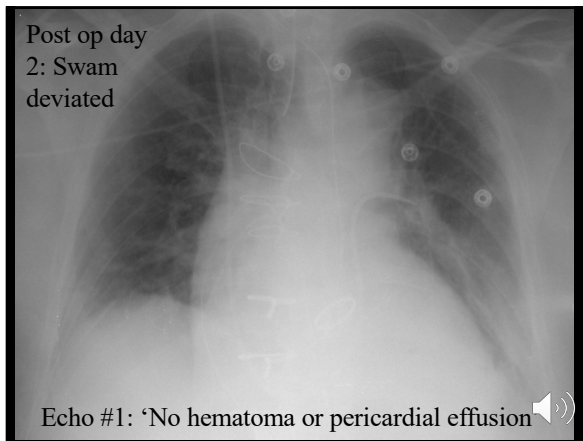
67

Post Op Cardiac Surgery: Day 1



68

Post op day
2: Swan
deviated



Echo #1: 'No hematoma or pericardial effusion'



69

Echo #2: 'No hematoma or pericardial effusion'



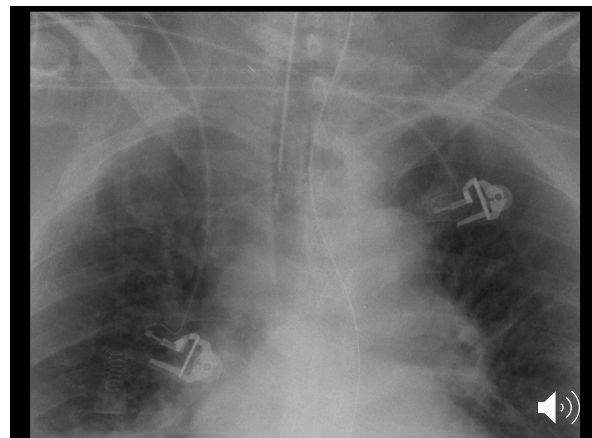
70

Endotracheal Tube: Position And Cuff

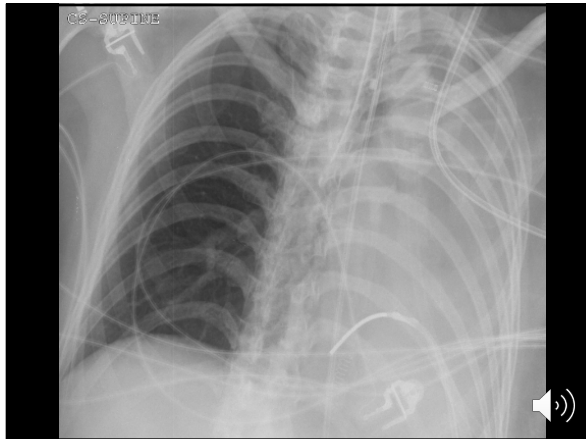
- Conventional Tip Recommendations: 4 – 6 cm above carina with neck neutral – But this is situation dependant (i.e. Pneumomediastinum)
- “**The hose follows the nose**”: ETT movement is *minimal* with Neck flexion and extension (More important in premature infants)
- **Balloon Cuff /Tracheal lumen > 1.5**: Call!
- Cuff pressure too high, Cuff in hypopharynx, tracheomalacia or tracheal laceration



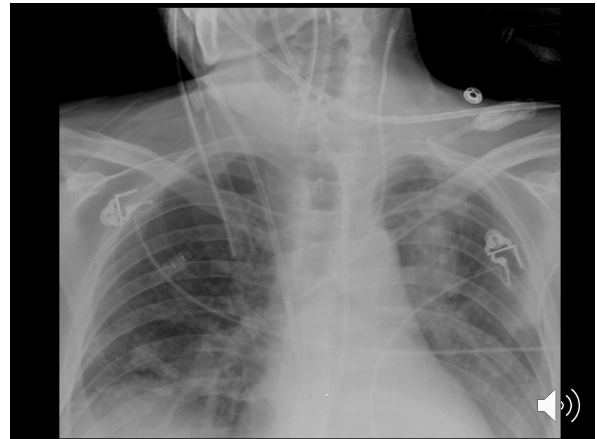
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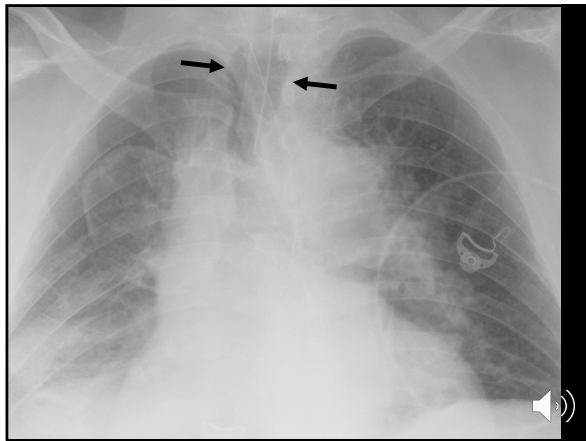
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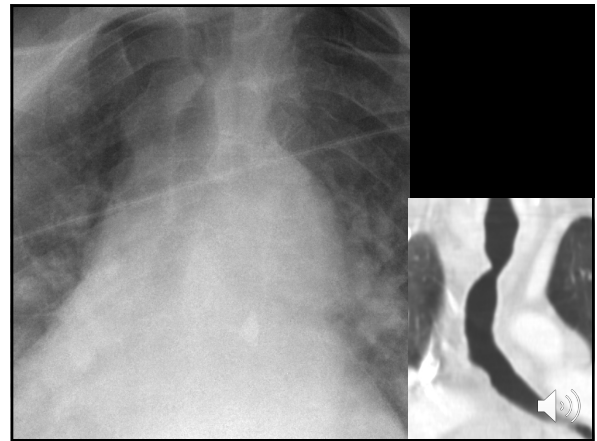
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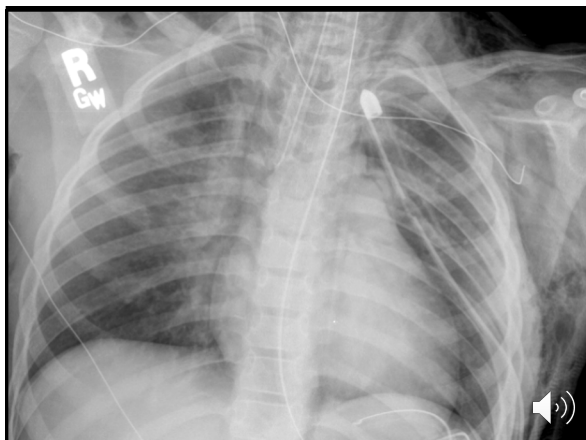
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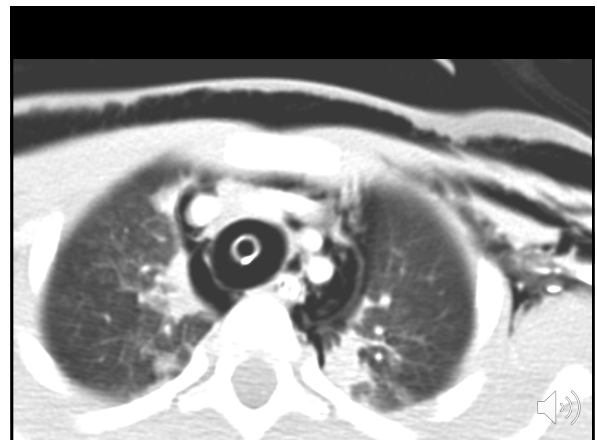
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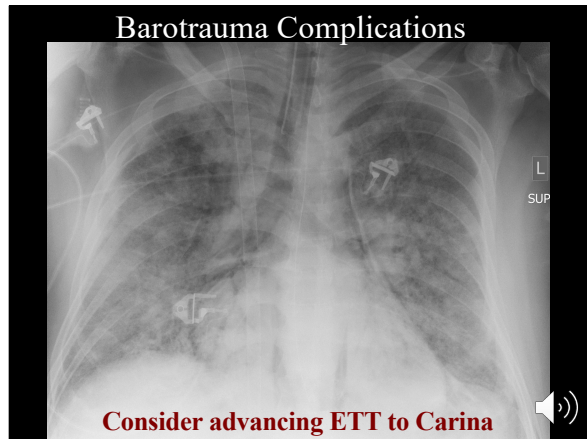
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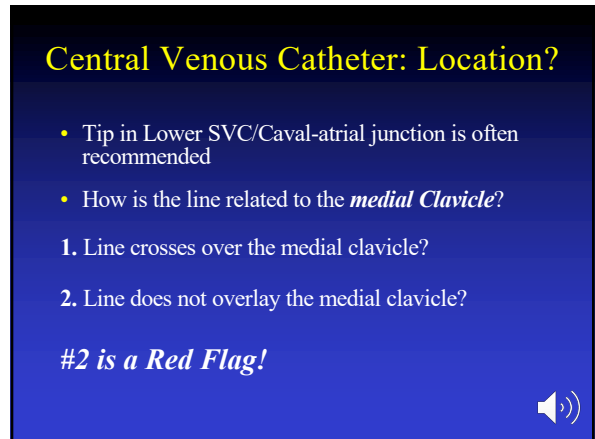
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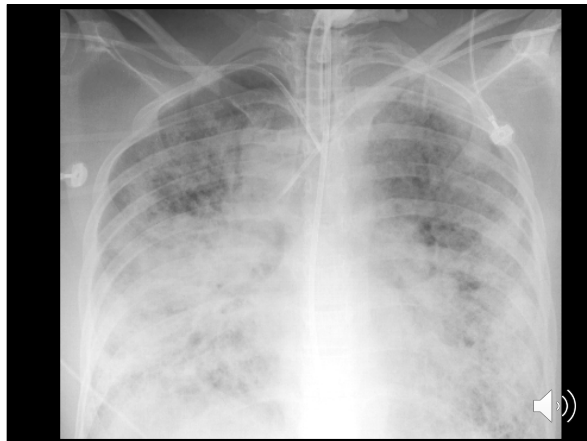
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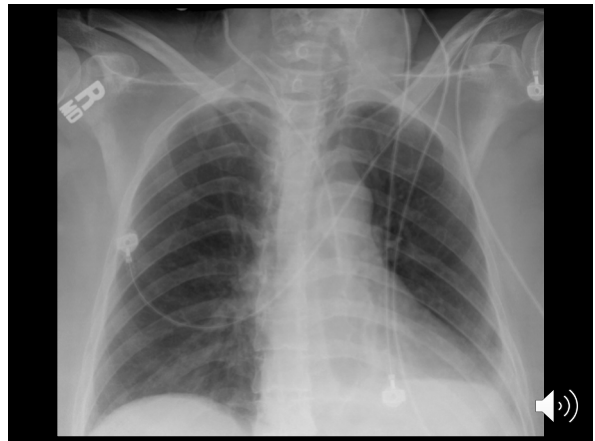
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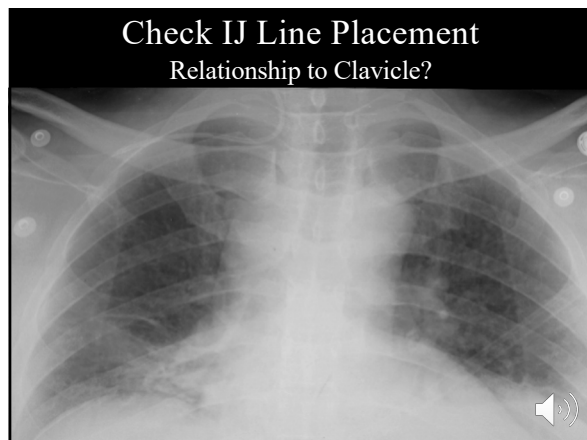
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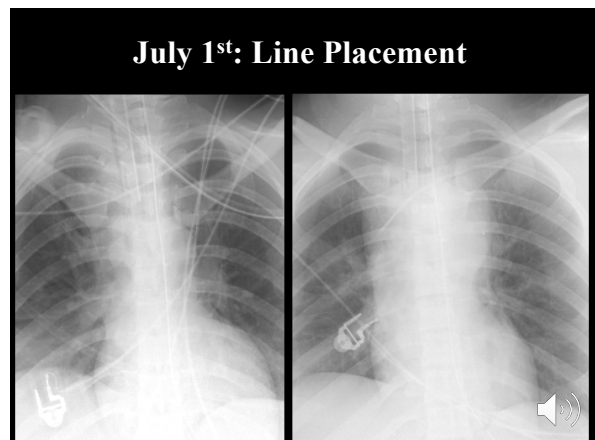
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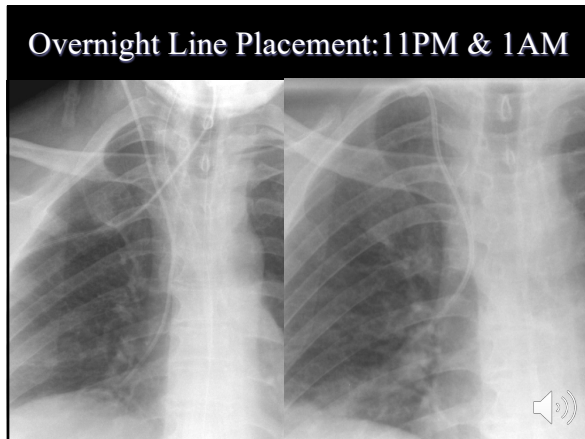
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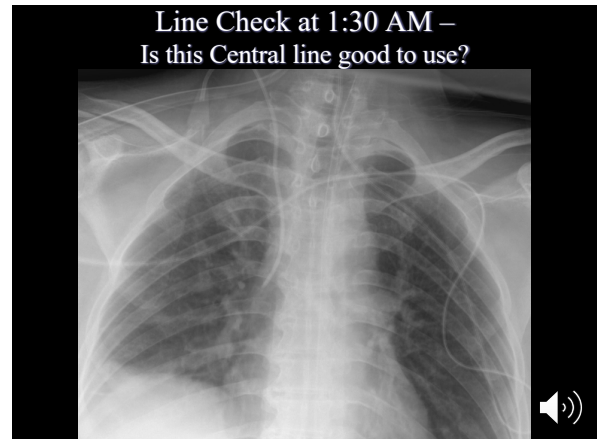
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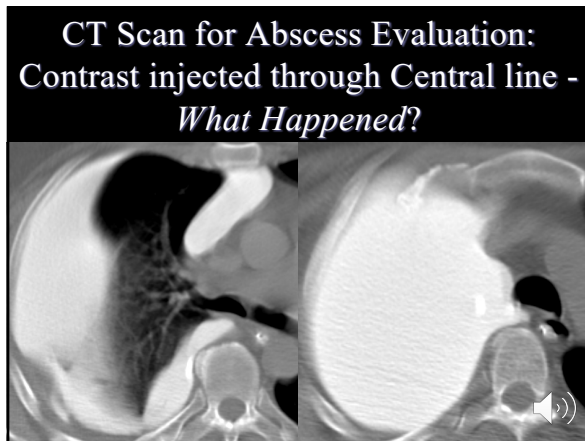
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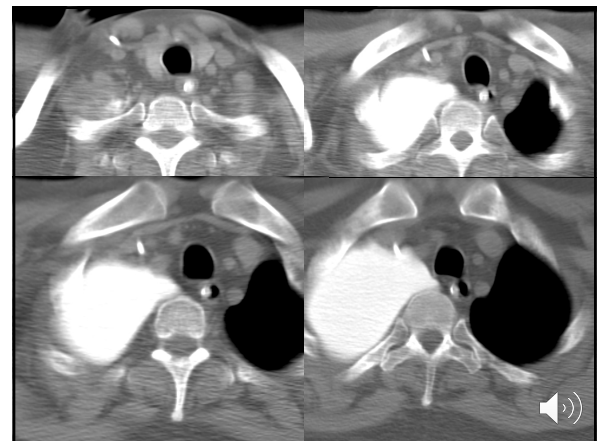
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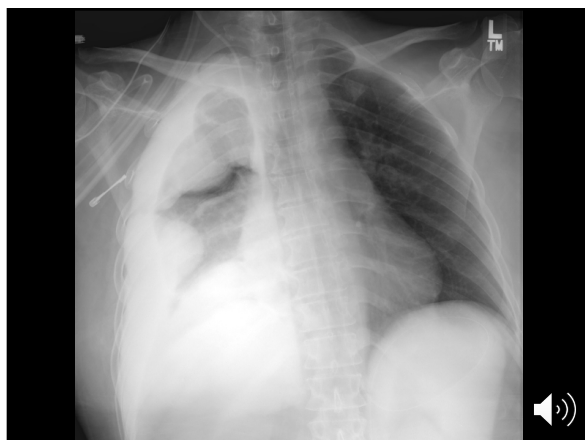
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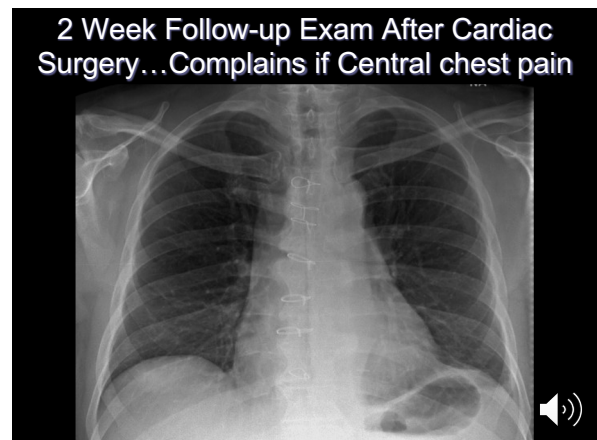
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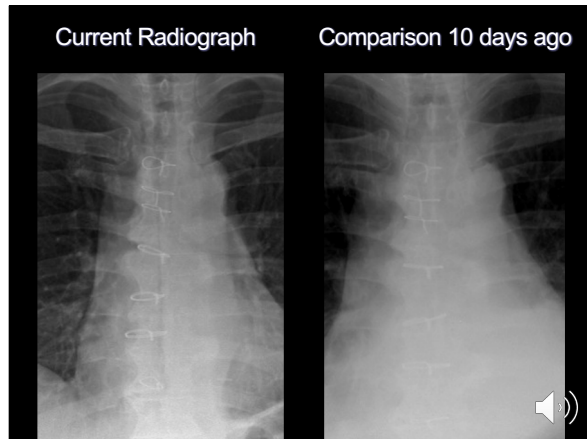
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89



90




91



92

Critical Care Imaging: Summary

- **Mantra to say each day:** *“There are at least 2 important abnormalities I will find on these ICU exams”*
- Remember to compare with **multiple** priors, especially on more chronic patients
- Work into your standard visual scan *those areas that often ignored. Someone needs to at least look at these.*



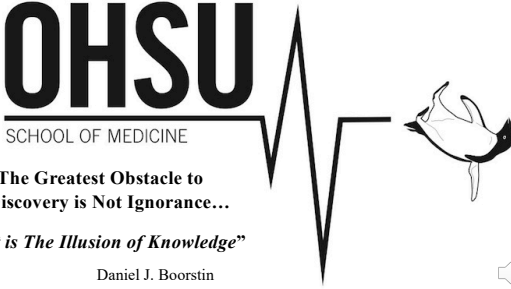
93

Thank You: mgosselin@visionradiology.com
or gosselin@OHSU.edu

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SCHOOL OF MEDICINE

**“The Greatest Obstacle to
Discovery is Not Ignorance...
It is The Illusion of Knowledge”**

Daniel J. Boorstin



94