Brigham and Women's Hospital
Founding Member, Mass General Brigham

Can't Miss Radiology Diagnoses

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October 2023

HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

Financial Disclosures

None

Lecture Outline

Over the next 50-55 minutes, the audience will be able to:

- Interpret basic chest radiographs
- Recognize and locate various tubes and lines
- Identify "can't miss radiology diagnoses" on plain x-ray and CT
- Discuss various imaging protocols and considerations
- Recognize the pros and cons of IV and PO contrast use in CT
- Optimally triage renal failure and contrast allergy patients

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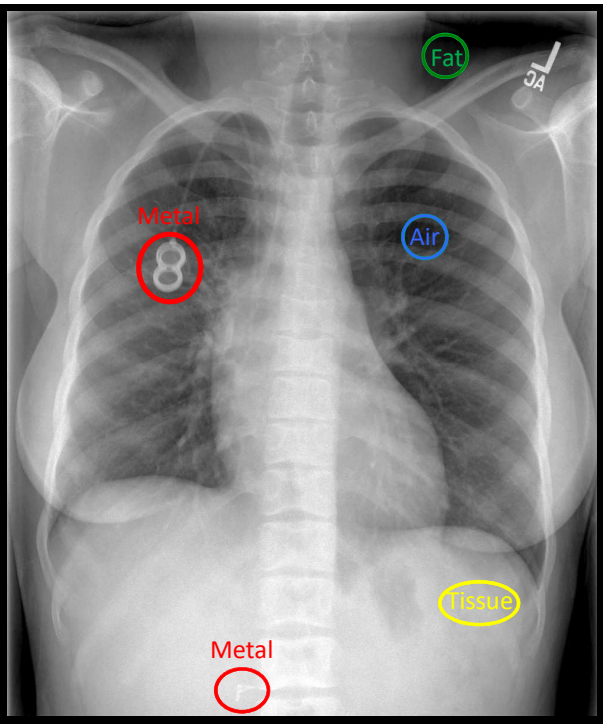
Part I: Interpreting chest radiographs

"Opacities could represent atelectasis, pleural effusion, or pulmonary edema, however, airspace disease/pneumonia cannot be excluded."

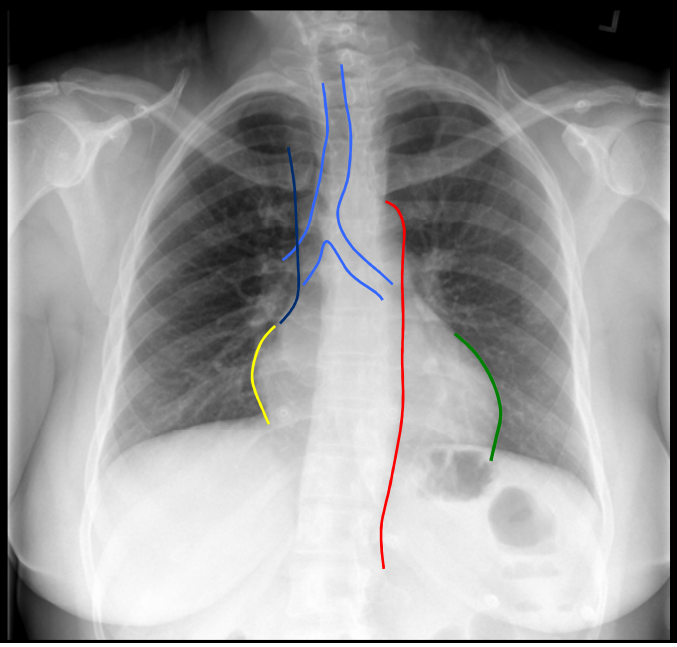
Conventional Radiographs

1. Air
2. Fat
3. Tissue (water)
4. Metal (bone)

#1



Normal Chest Radiograph



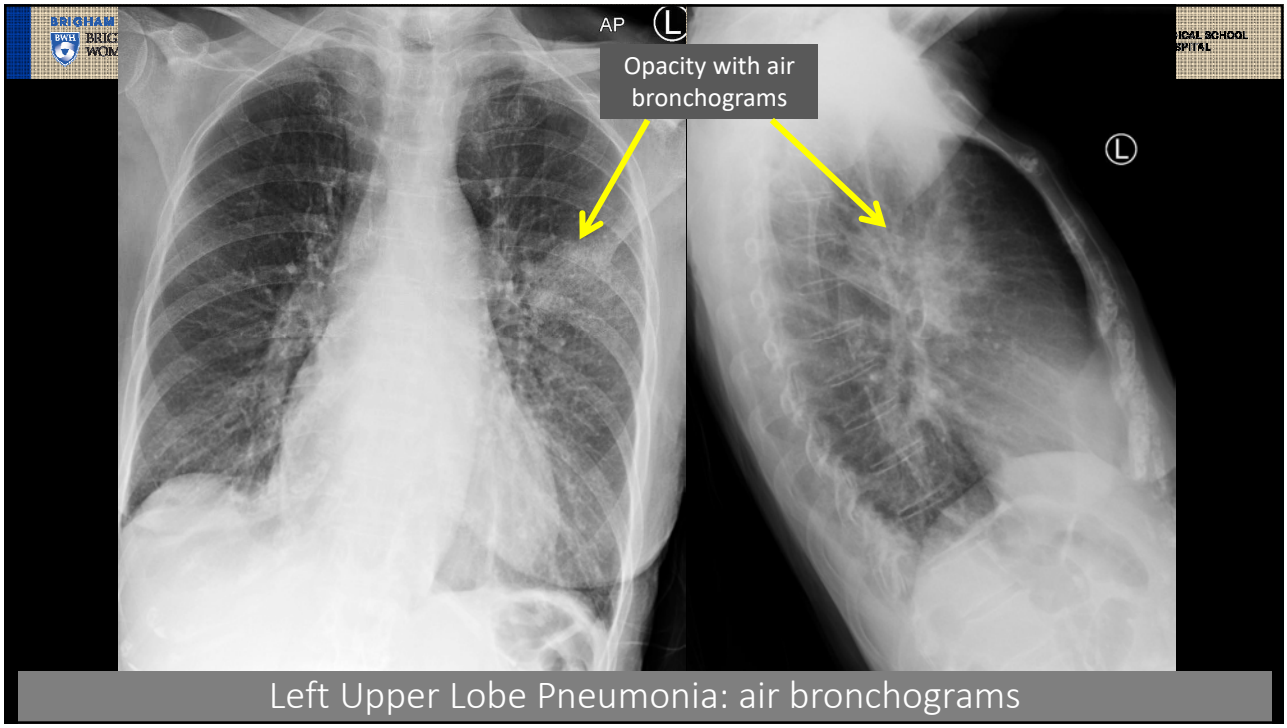
Trachea

Right paratracheal stripe: SVC

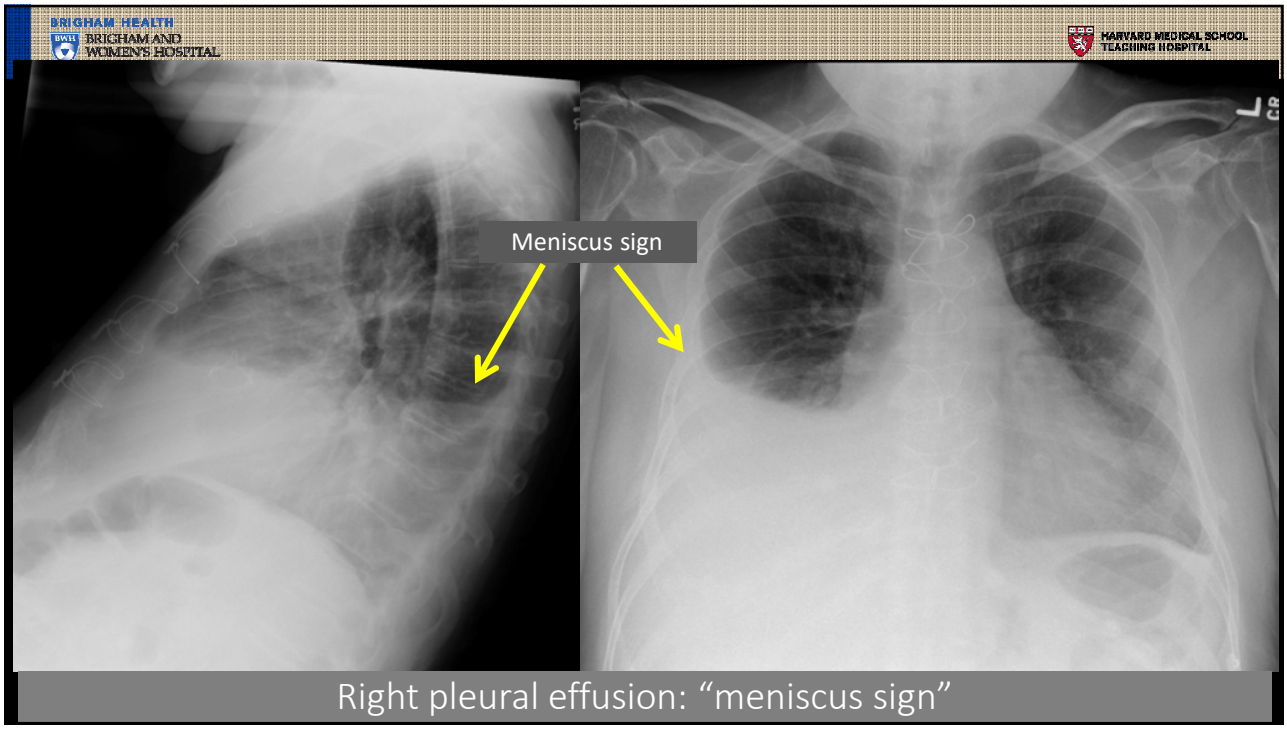
Aortic knob and descending thoracic aorta

Right heart border: Right atrium

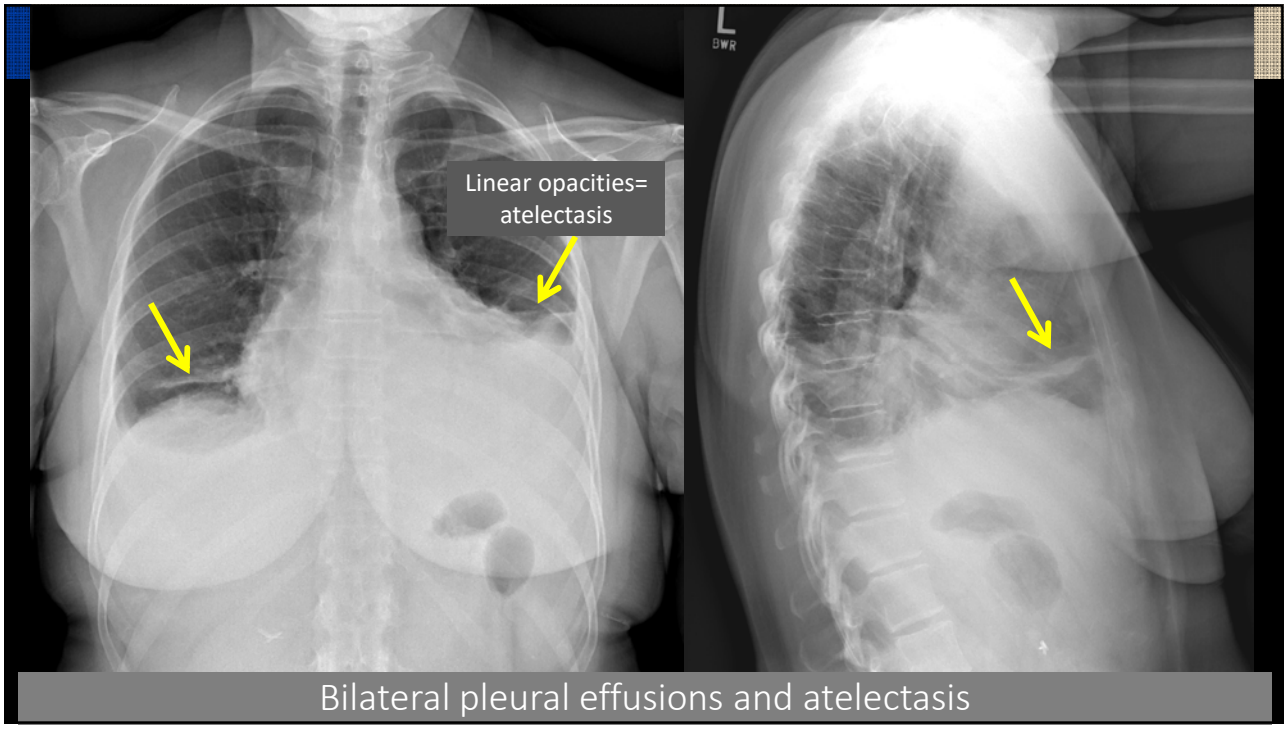
Left heart border: left ventricle



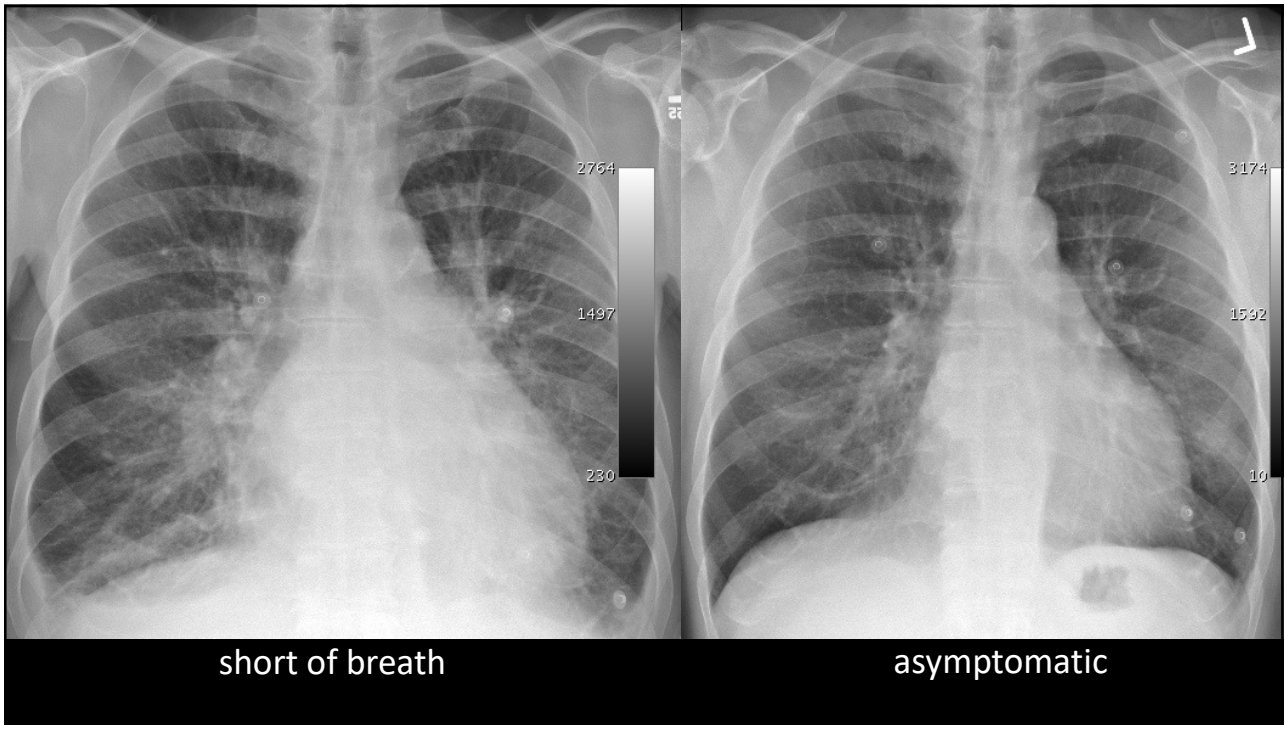
Left Upper Lobe Pneumonia: air bronchograms

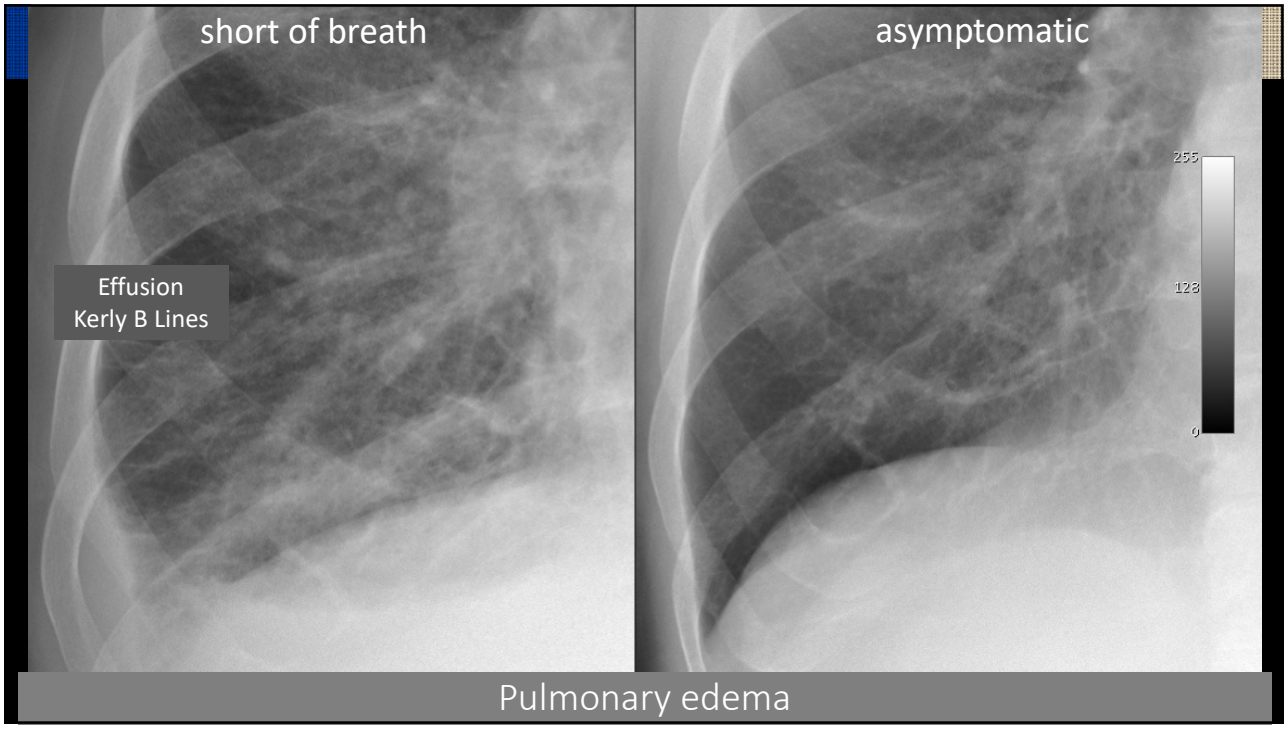


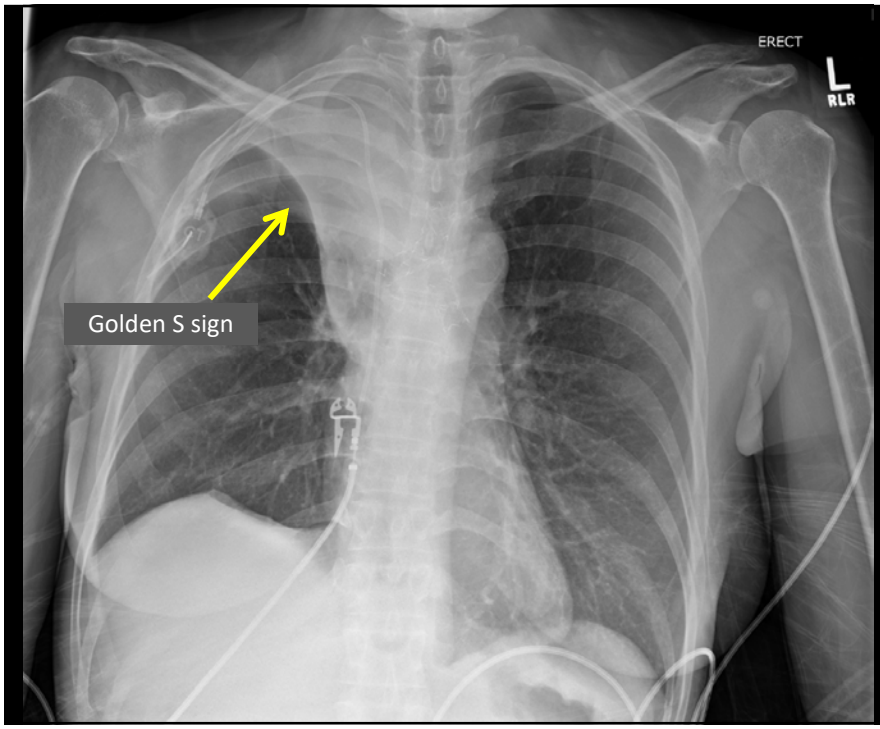
Right pleural effusion: “meniscus sign”



Bilateral pleural effusions and atelectasis


2764
1497
230
3174
1532
10
short of breath
asymptomatic


short of breath
asymptomatic
Effusion
Kerly B Lines
255
128
0
Pulmonary edema



Right upper lobe collapse

Complete whiteout: Atelectasis vs. Effusion

Atelectasis

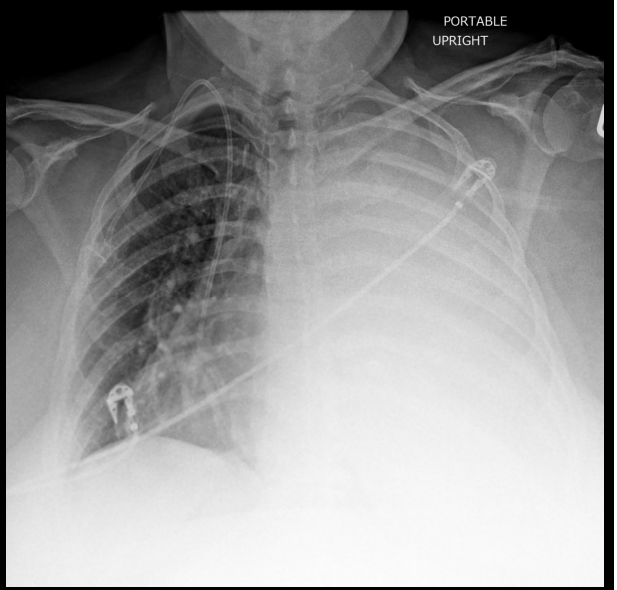
Imaging findings:

Whiteout with volume loss-elevation of hemidiaphragm and ipsilateral tracheal & mediastinal shift

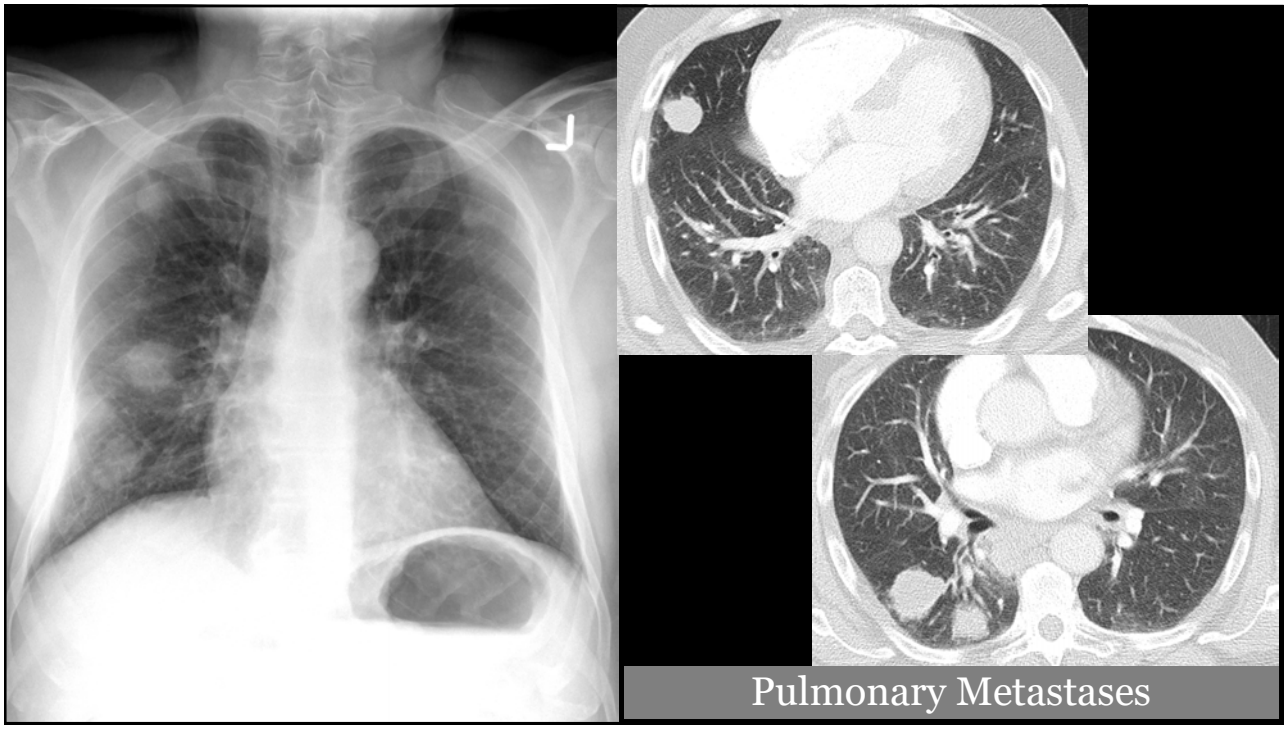
Large Pleural Effusion

Imaging findings:

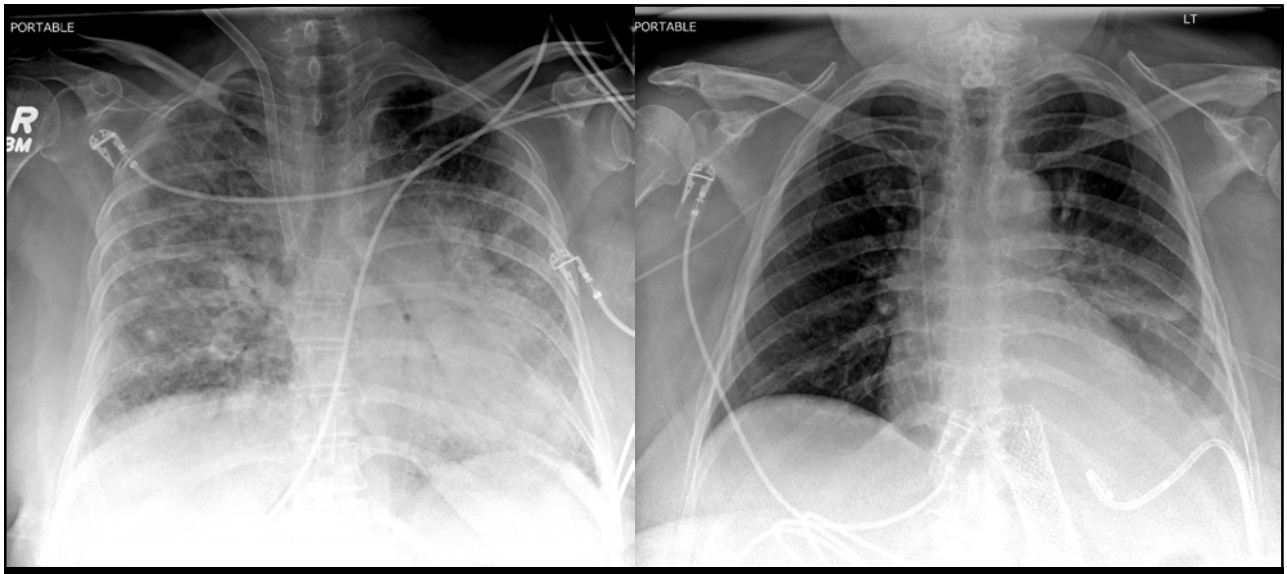
Whiteout with mass effect-contralateral tracheal & mediastinal shift



1200 mL serosanguineous fluid



Pulmonary Metastases



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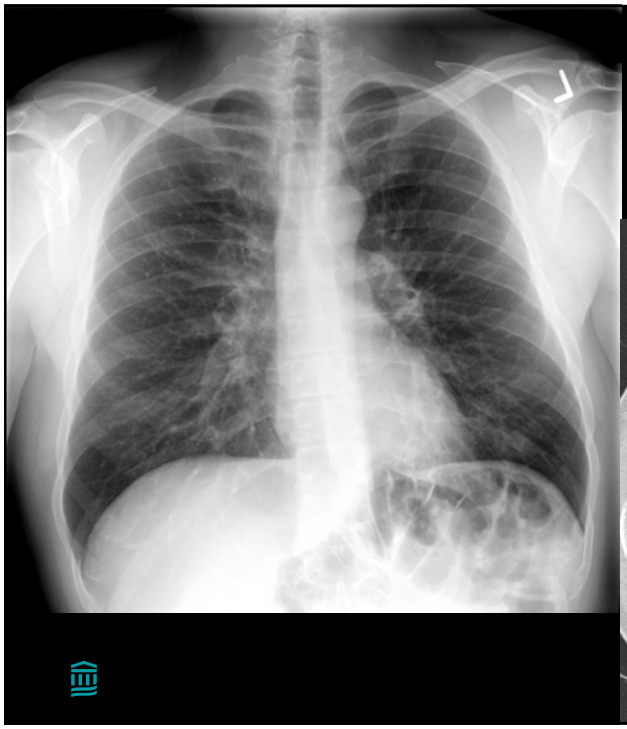
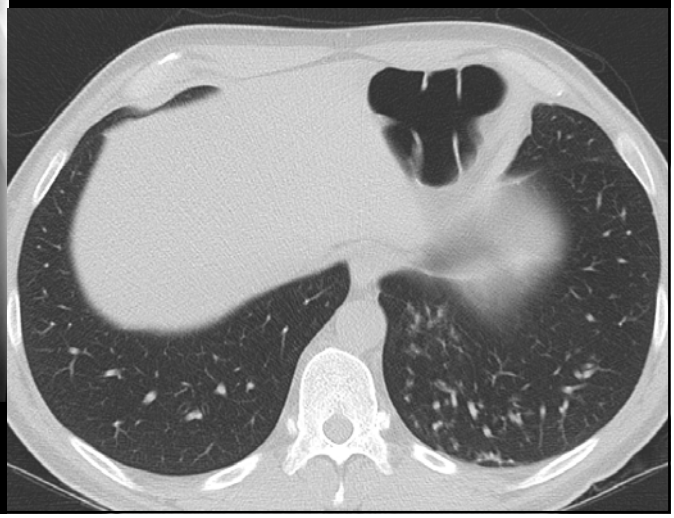
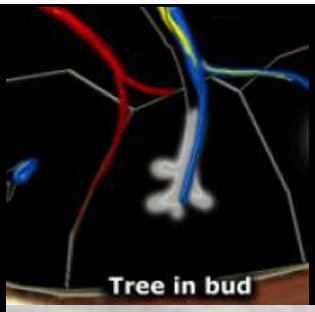


#2

CT has better contrast discrimination





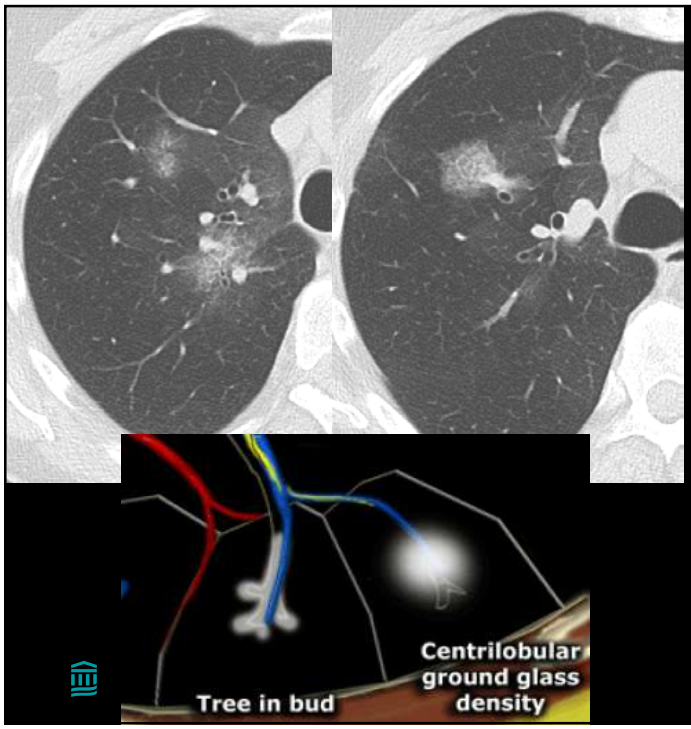
“Tree-in-bud” opacities

Irregular, nodular branching pattern
Represent dilated and impacted centrilobular bronchioles

Infection (endobronchial spread)
- bacterial, fungal, MAC

Airway disease
- CF, bronchiectasis

Allergic bronchopulmonary aspergillosis
Aspiration



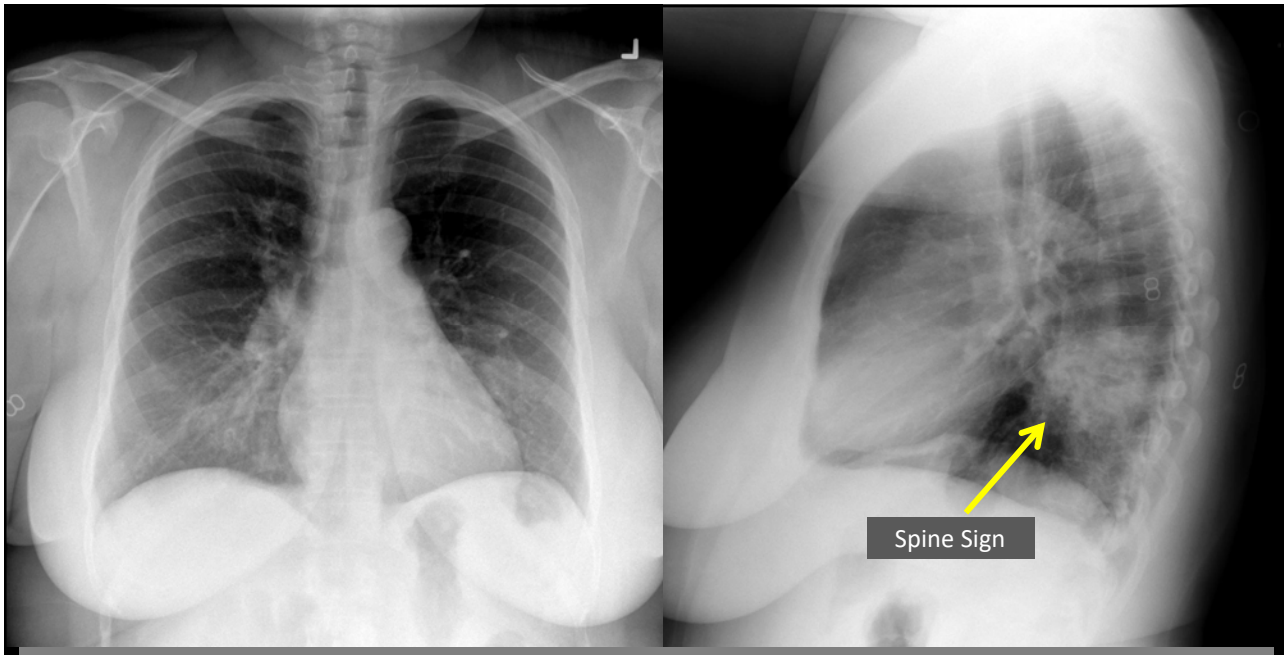
“Ground Glass” Opacities

Increased lung attenuation without obscuring underlying vessels
Replacement of air in alveoli by

- Fluid (pus, edema, hemorrhage),
- Cells (tumor),
- Fibrosis

#3

One View
is
No View



Left Lower Lobe Pneumonia

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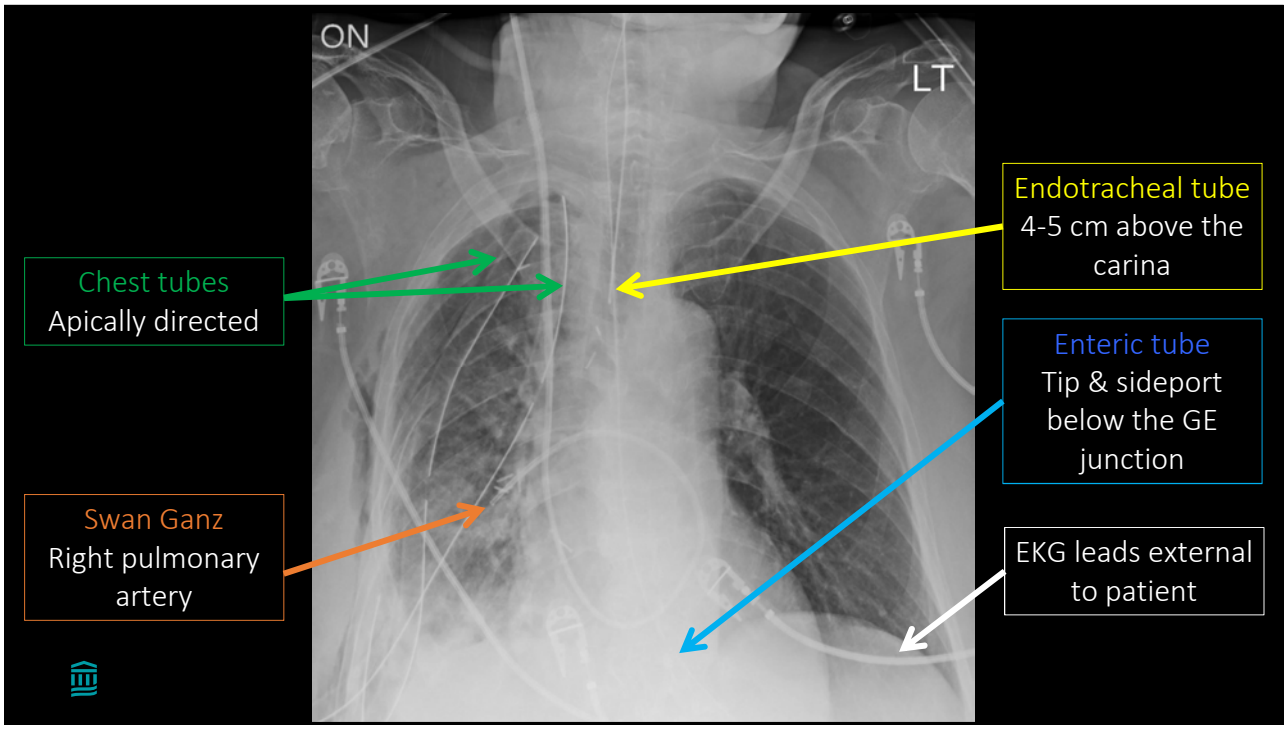
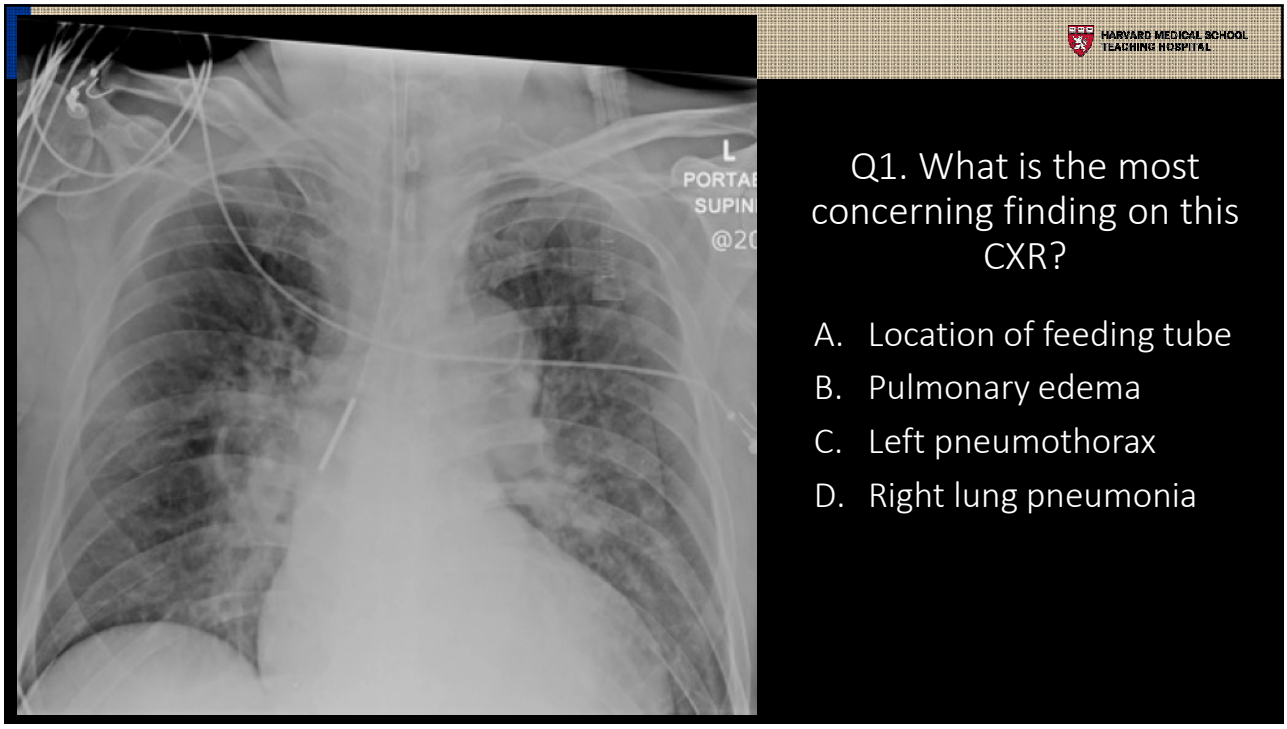
Part II: Tubes and lines


ON
LT
Chest tubes
Apically directed
Endotracheal tube
4-5 cm above the carina
Enteric tube
Tip & sideport below the GE junction
Swan Ganz
Right pulmonary artery
EKG leads external to patient


HARVARD MEDICAL SCHOOL
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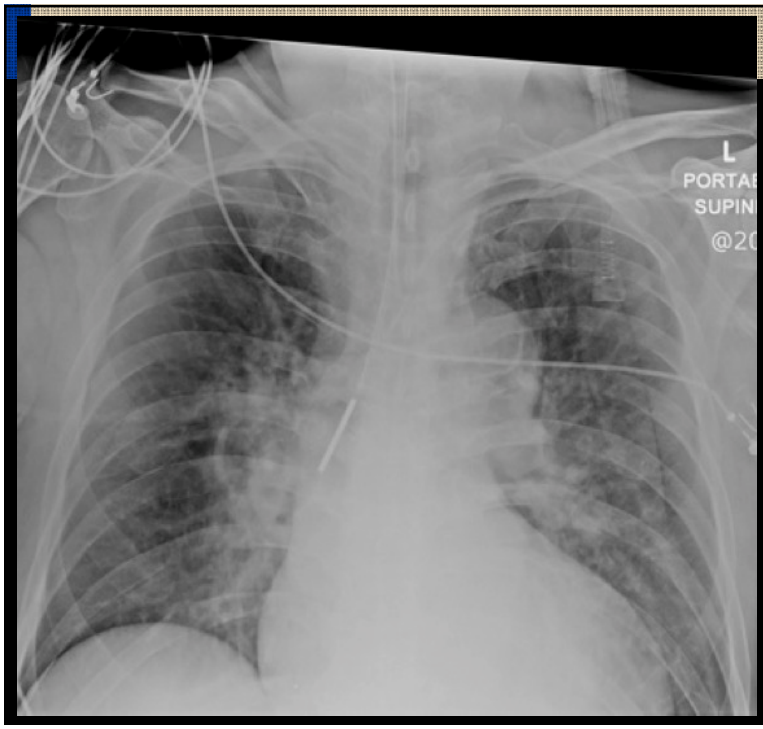
Q1. What is the most concerning finding on this CXR?
A. Location of feeding tube
B. Pulmonary edema
C. Left pneumothorax
D. Right lung pneumonia



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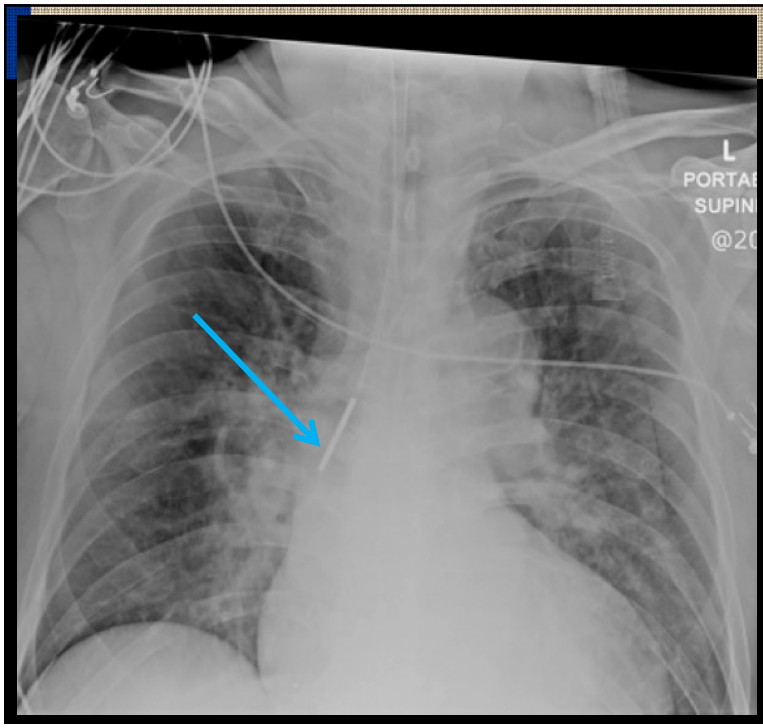

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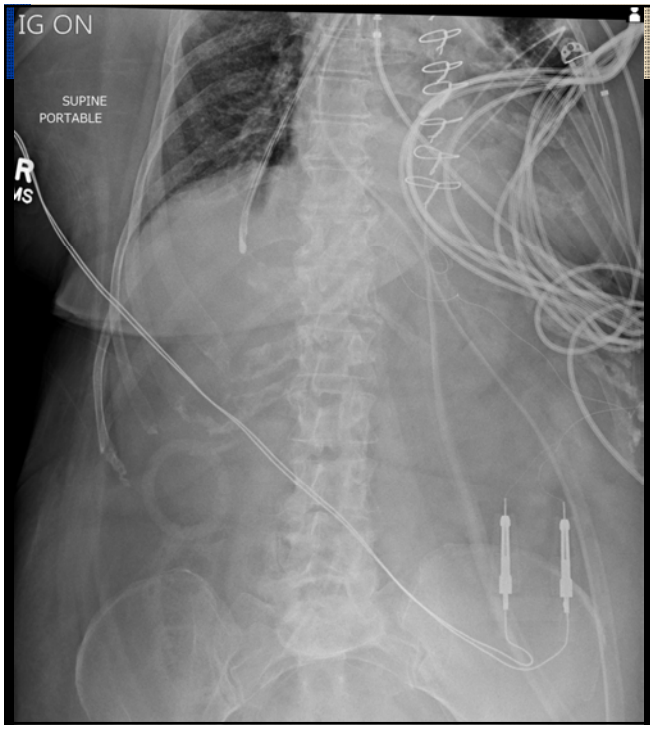
A. Location of feeding tube

Dobhoff tube is incorrectly located in the right mainstem bronchus.

Correct position: esophageal with tip below the diaphragm.

Do NOT feed the patient! Reposition Dobhoff.



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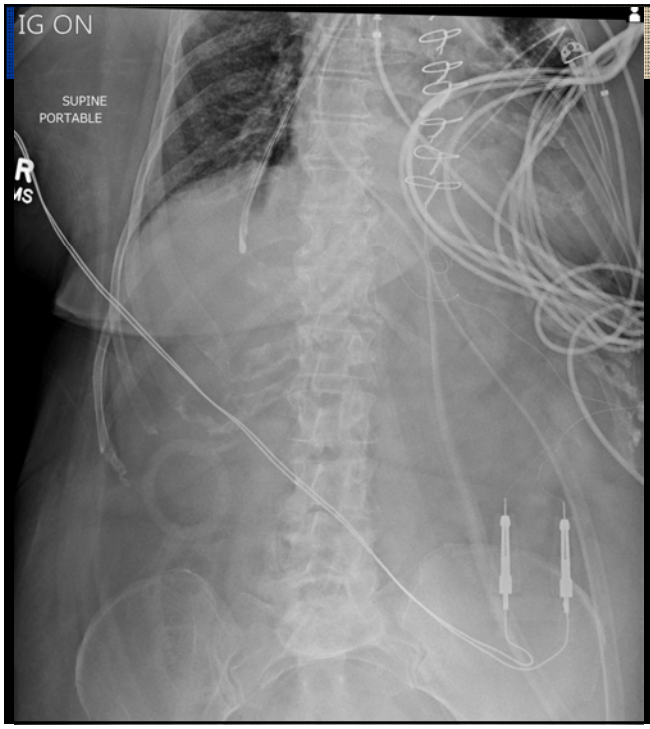
Q2. What is the next best step for this patient?

A. SBO oral contrast pathway
B. Exploratory laparotomy
C. Barium enema
D. Thoracic surgery consultation
E. Urology consultation



HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

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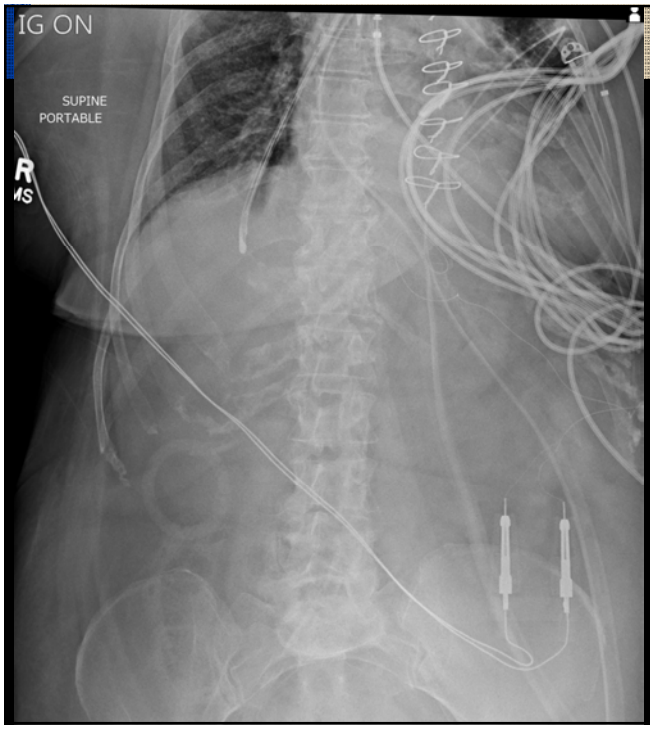

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D. Thoracic surgery consultation

Dobhoff tube is incorrectly located in the distal right lower lobe bronchus.

Correct position: esophageal with tip below the diaphragm.

Do NOT feed the patient!

Distal position of the Dobhoff may have perforated small bronchiole and could cause a tension pneumothorax upon removal

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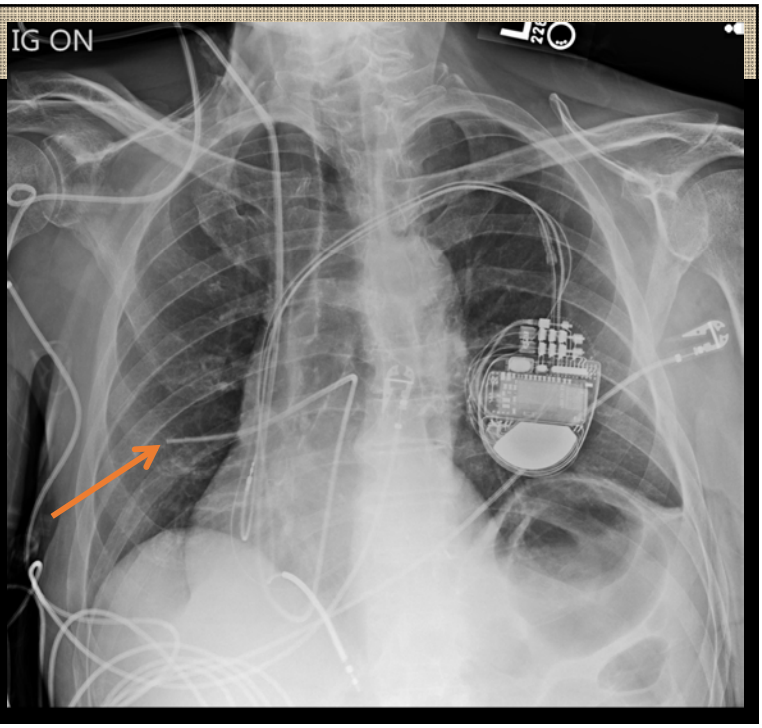
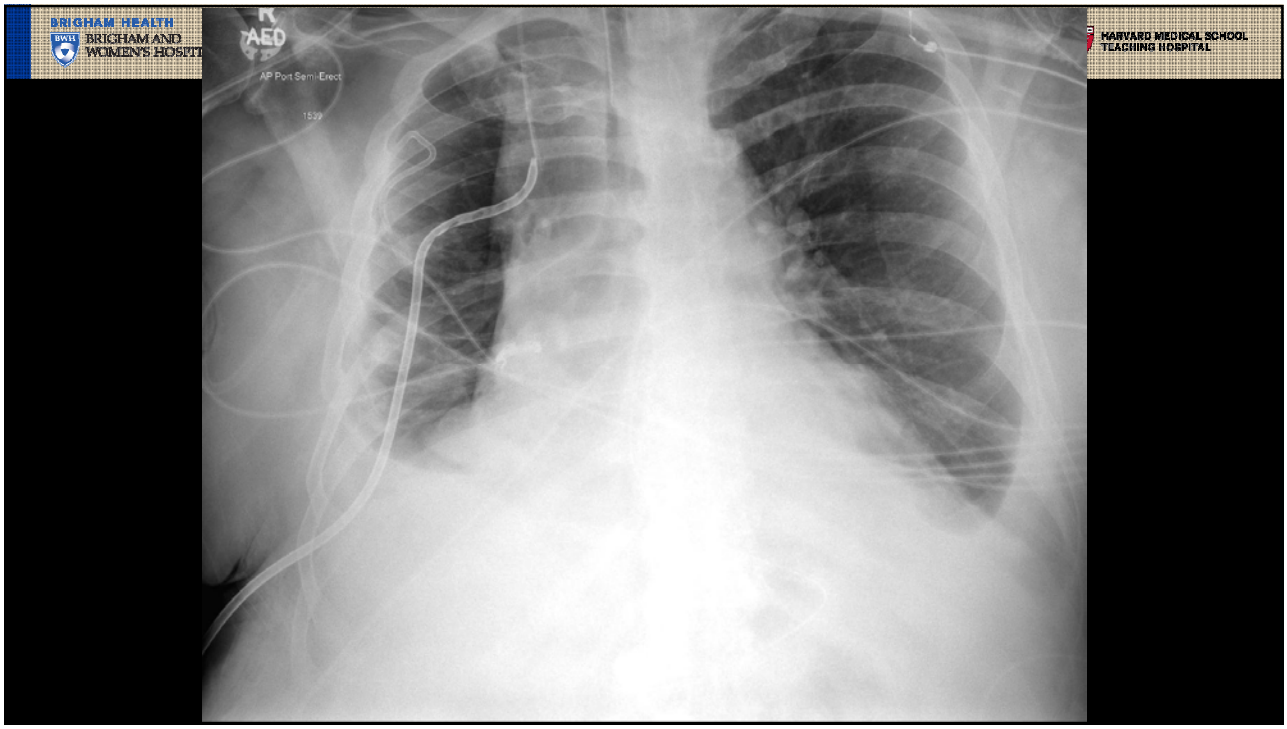
R IJ Swan Ganz catheter is incorrectly located in the distal right pulmonary artery.

Correct position: Proximal right pulmonary artery.

Retract catheter.

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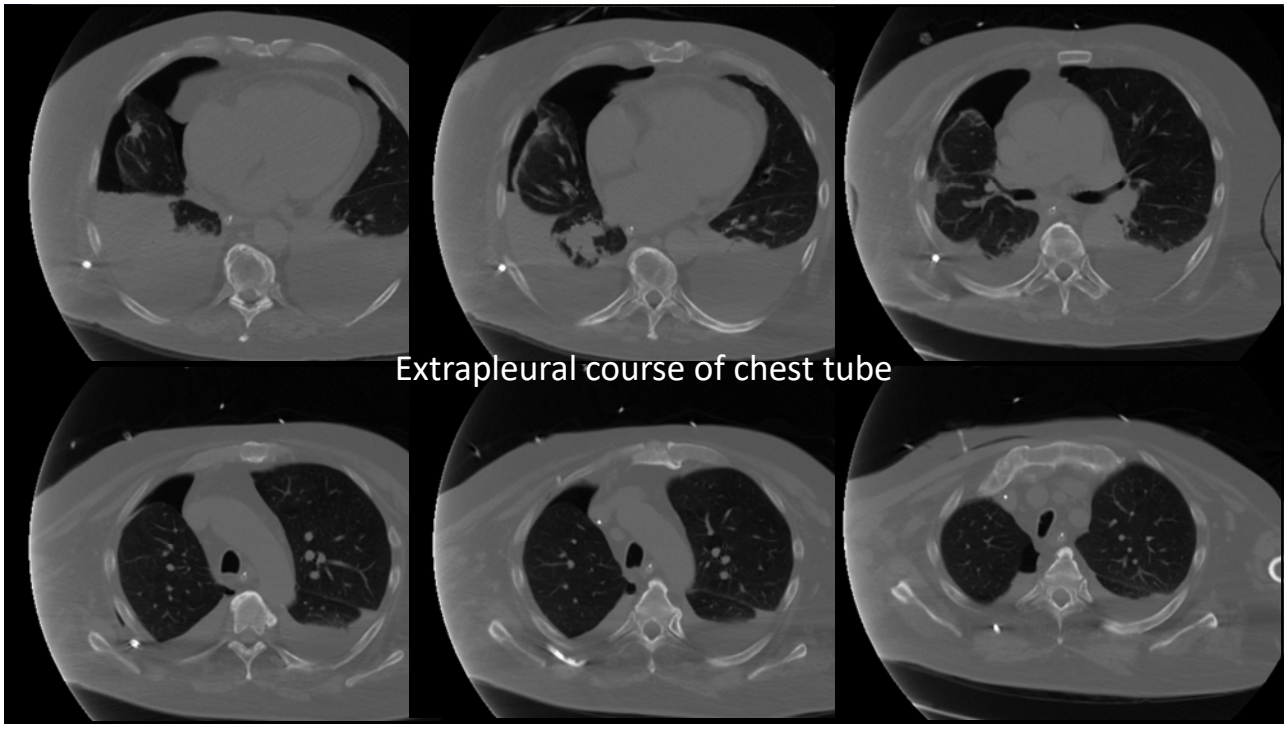
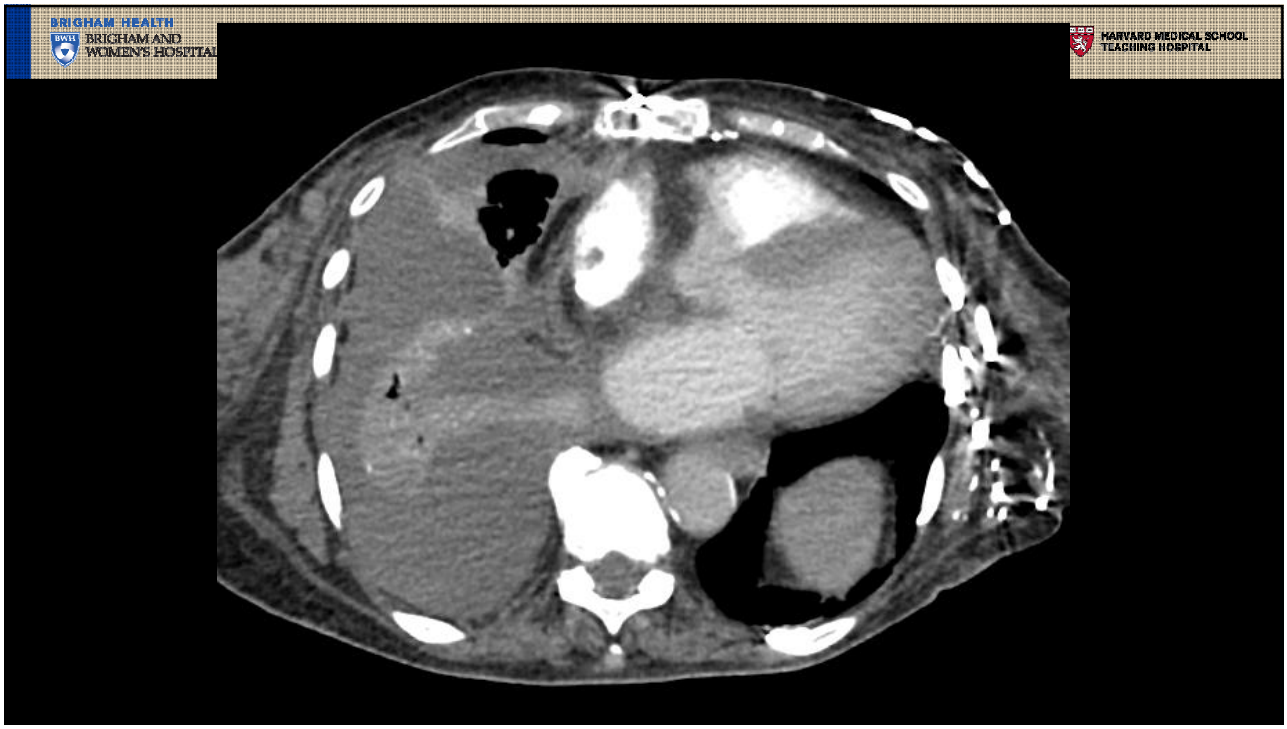
AED
AP Port Semi-Erect


Extrapleural course of chest tube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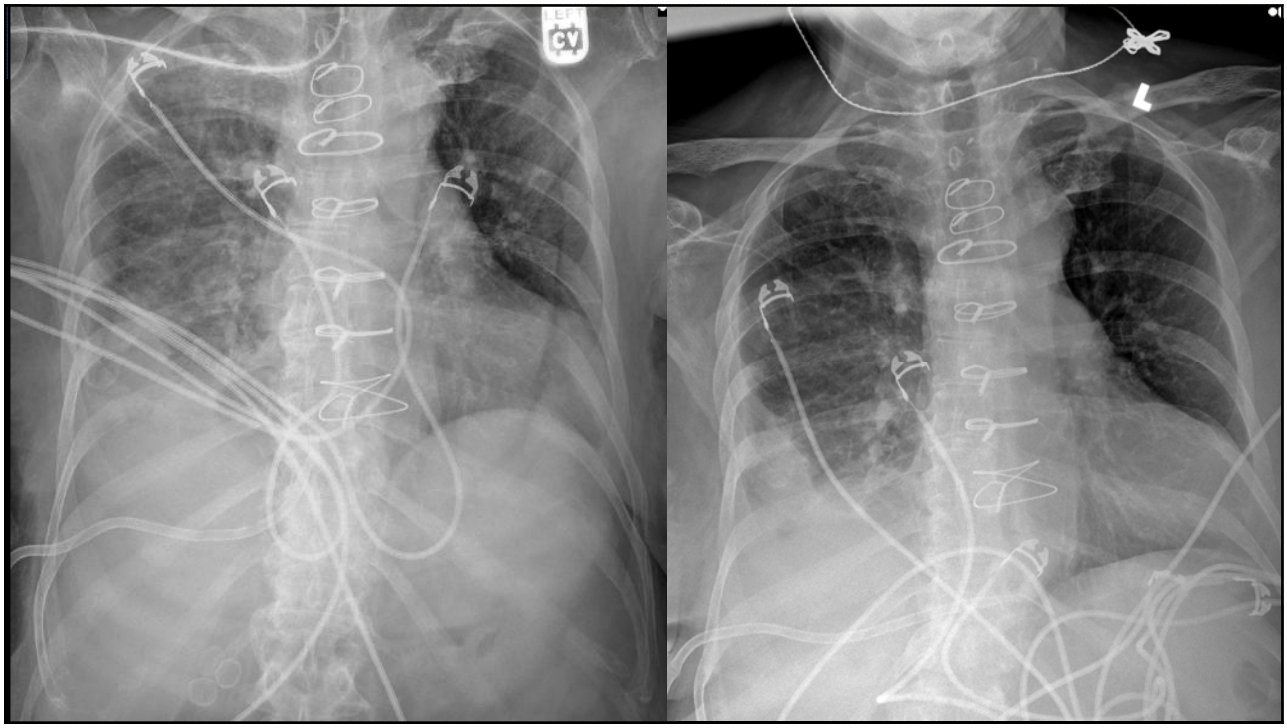
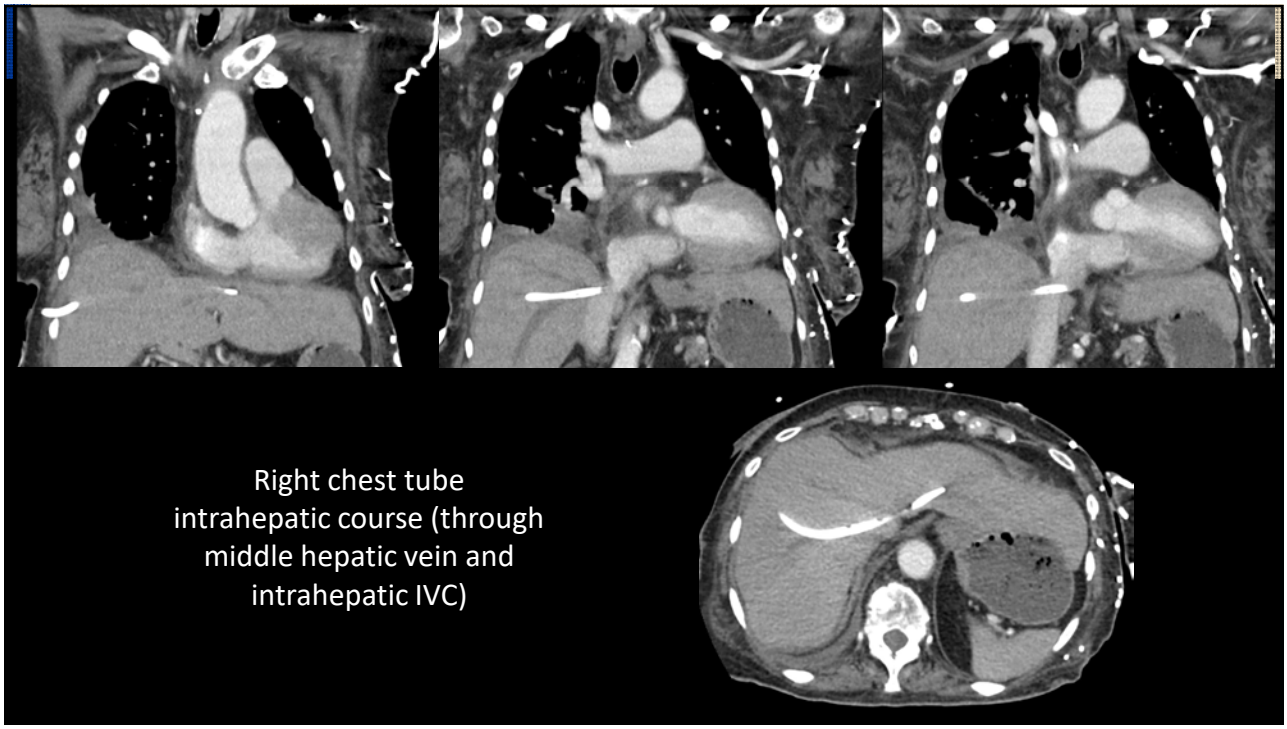

CV
L



Right chest tube intrahepatic course (through middle hepatic vein and intrahepatic IVC)

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Part III: Can't Miss Radiology Diagnoses

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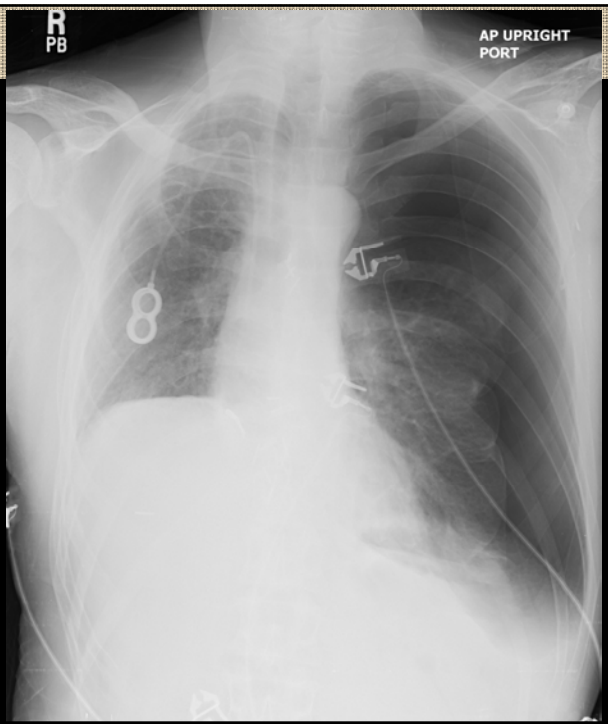
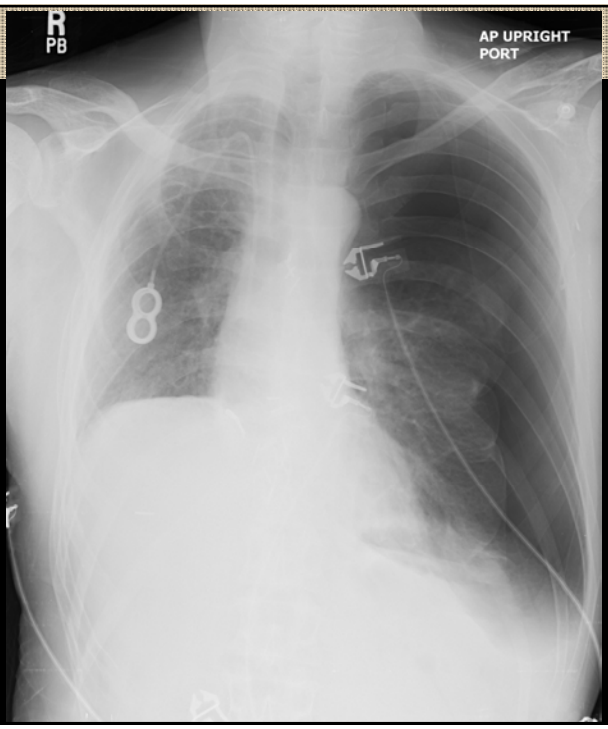


Q3. What is the most concerning finding on this CXR?

A. Location of Port catheter
B. Left pleural effusion
C. Left pneumothorax
D. Tension pneumothorax



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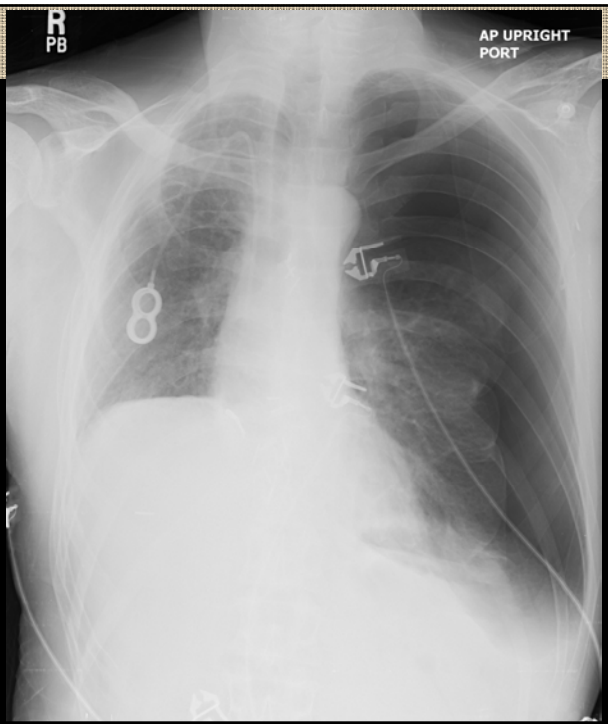

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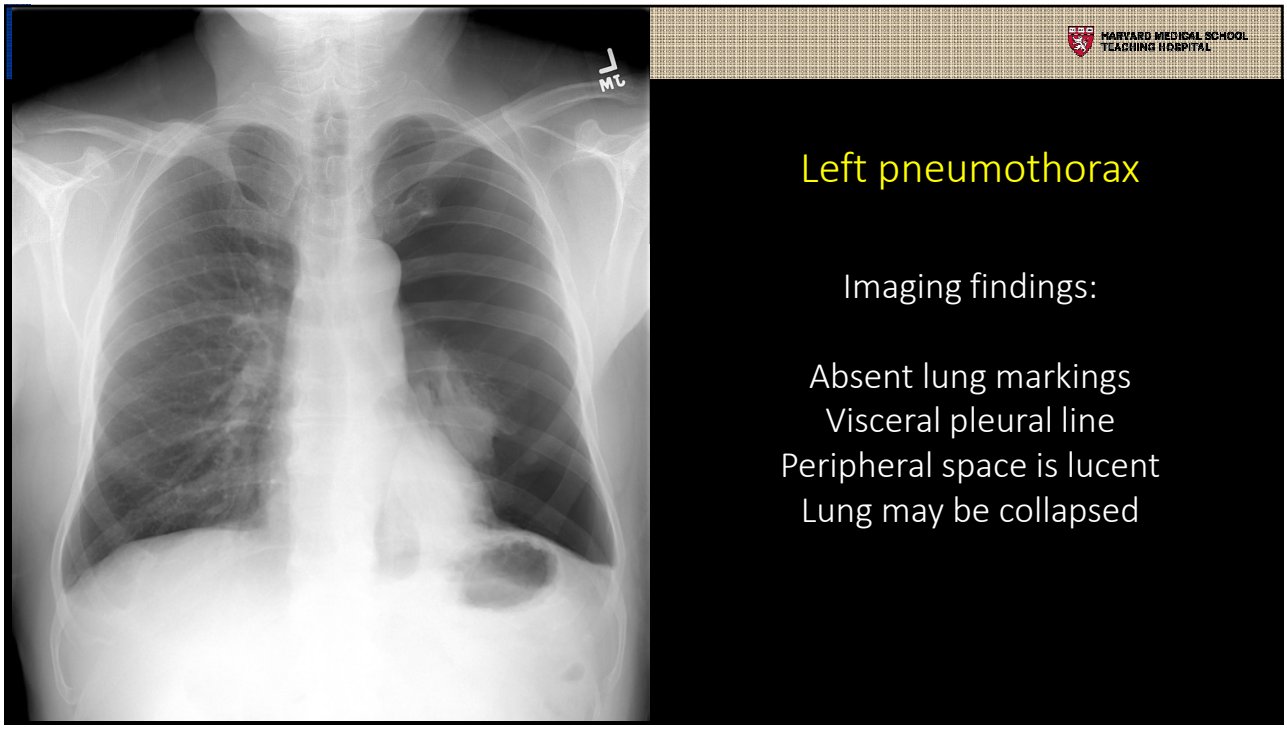
D. Tension Pneumothorax

Imaging findings:

Pneumothorax with

Ipsilateral increased intercostal spaces
Contralateral mediastinal shift
Depression of diaphragm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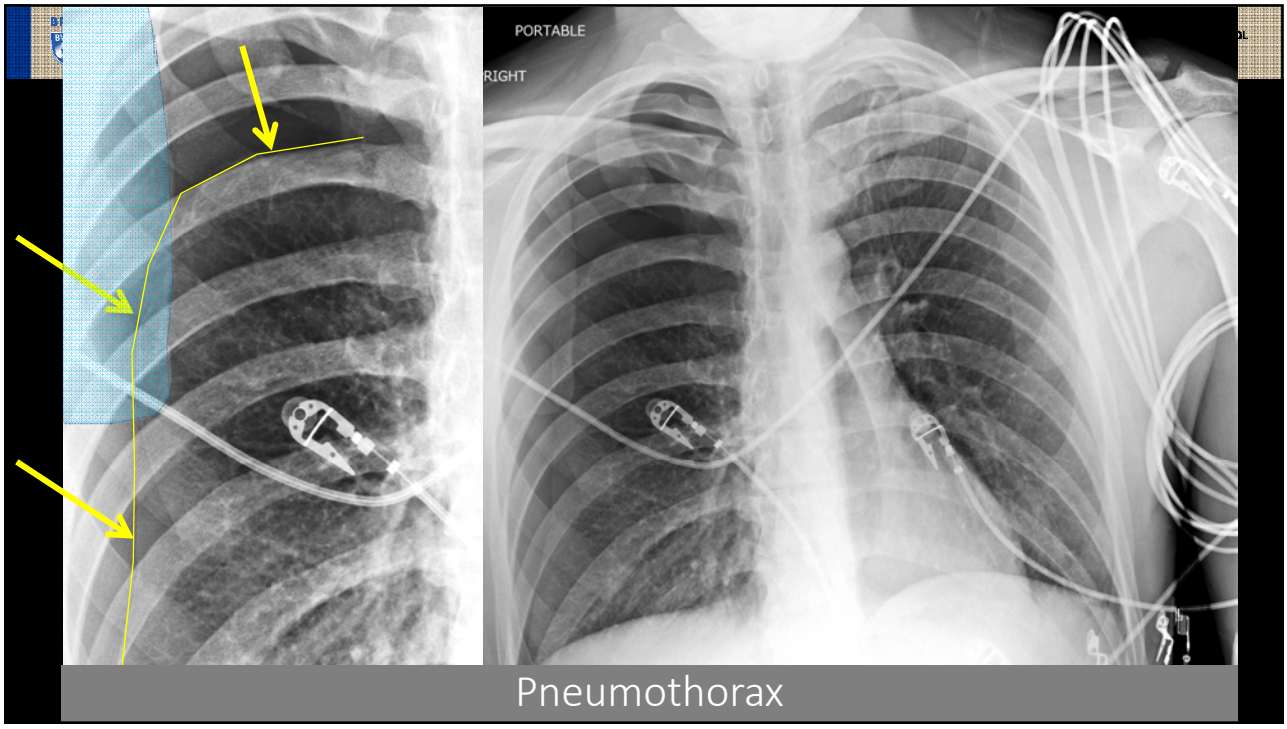
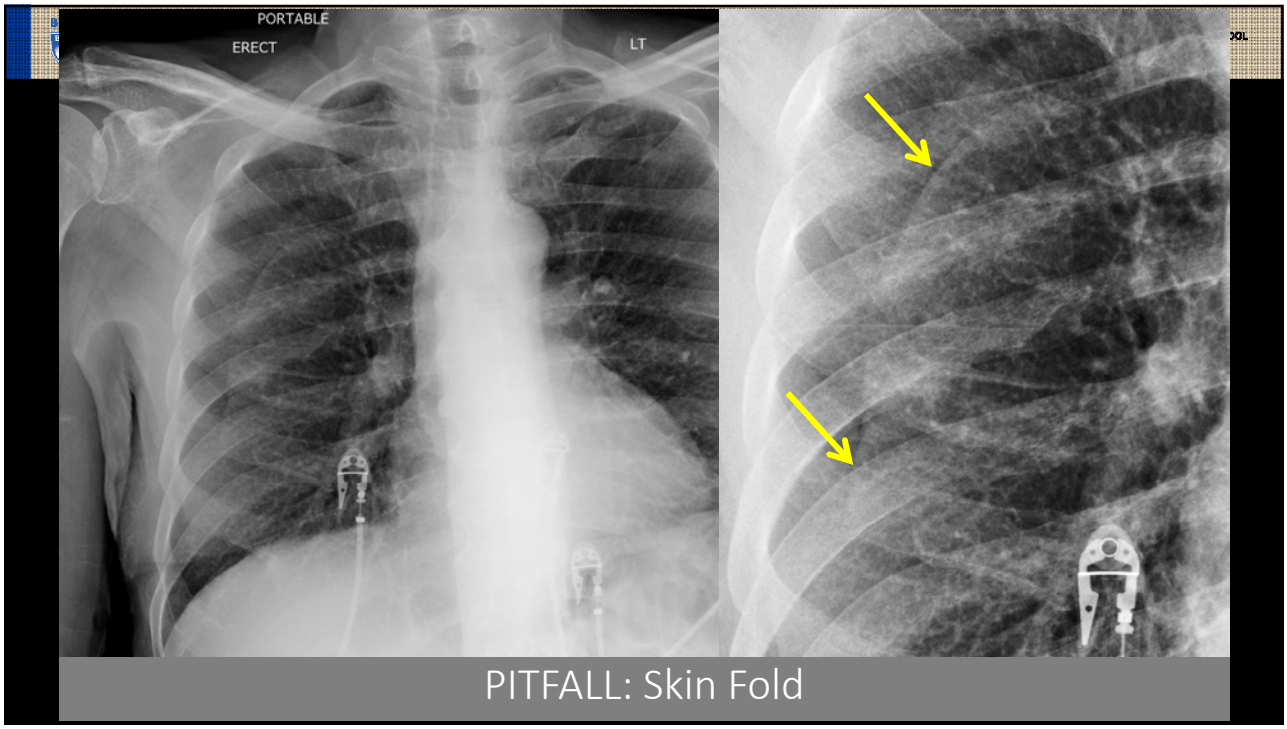
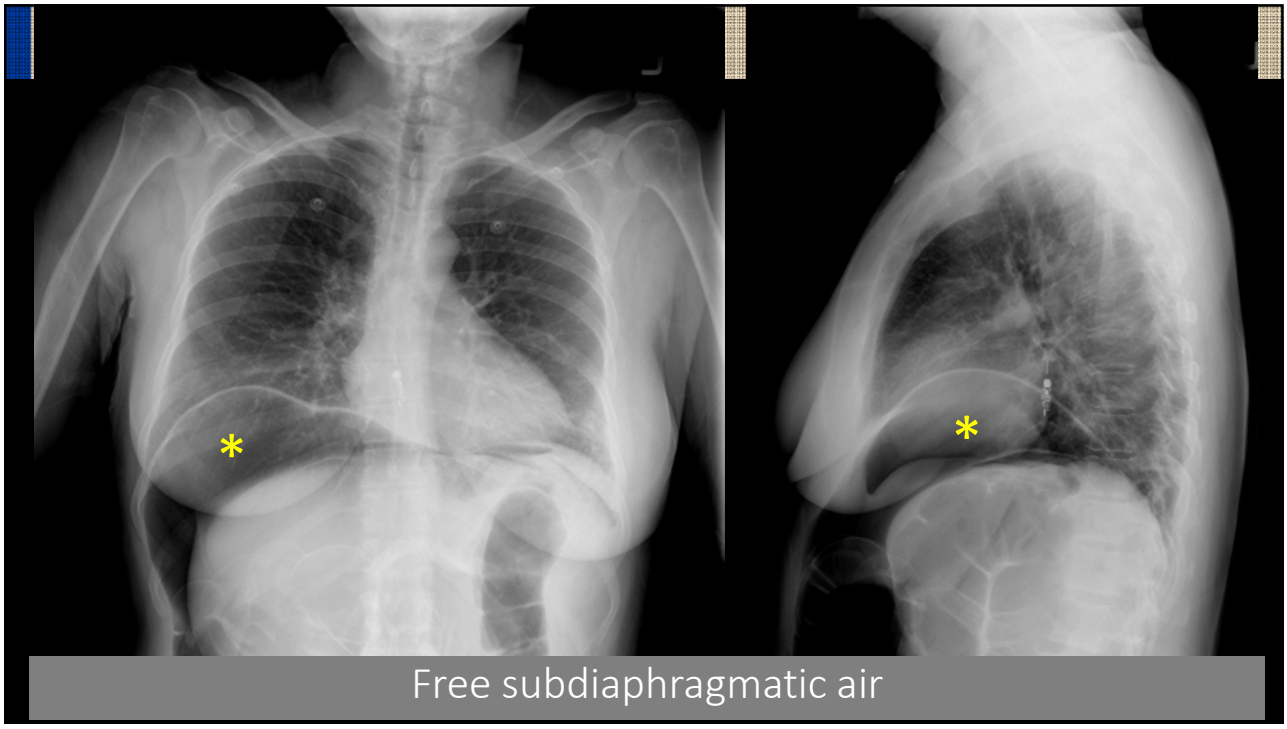
Left pneumothorax
Imaging findings:
Absent lung markings
Visceral pleural line
Peripheral space is lucent
Lung may be collapsed

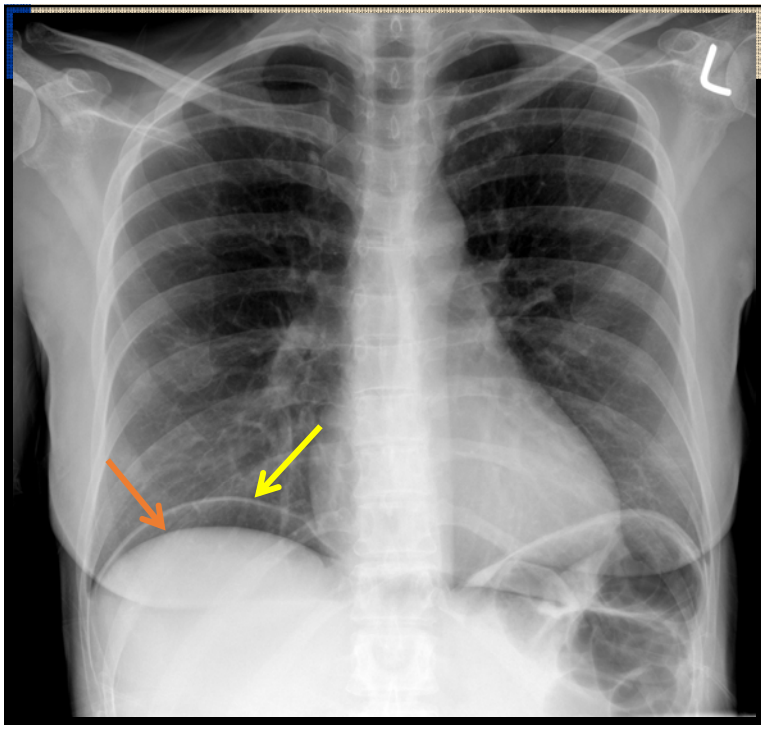

PORTABLE
RIGHT
Pneumothorax



PITFALL: Skin Fold



Free subdiaphragmatic air



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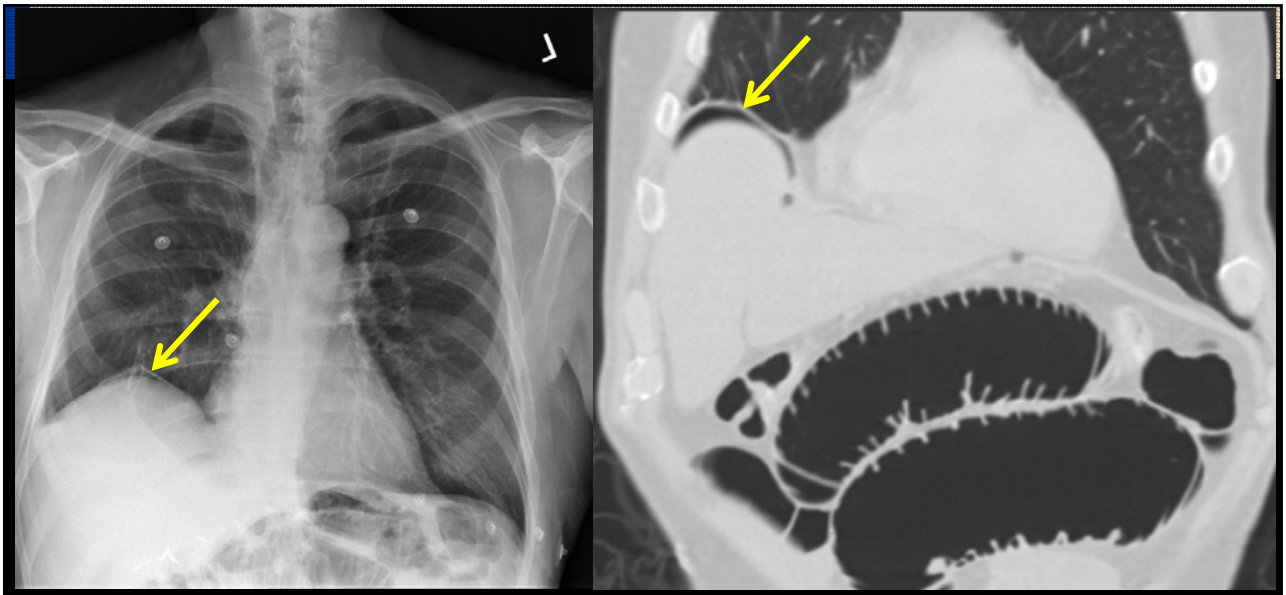
Subtle free subdiaphragmatic air

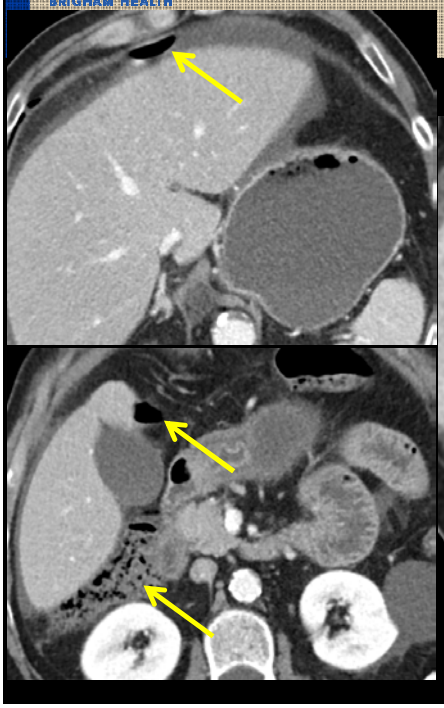
Identify liver & diaphragm

Lucency under hemidiaphragm

UPRIGHT radiograph is helpful to identify antidependent air



- Upright CXR can depict intraperitoneal gas as a lucency under the diaphragm
- CT is more sensitive for the detection of pneumoperitoneum and CT also shows the site of perforation in up to 85% of actual perforation sites.

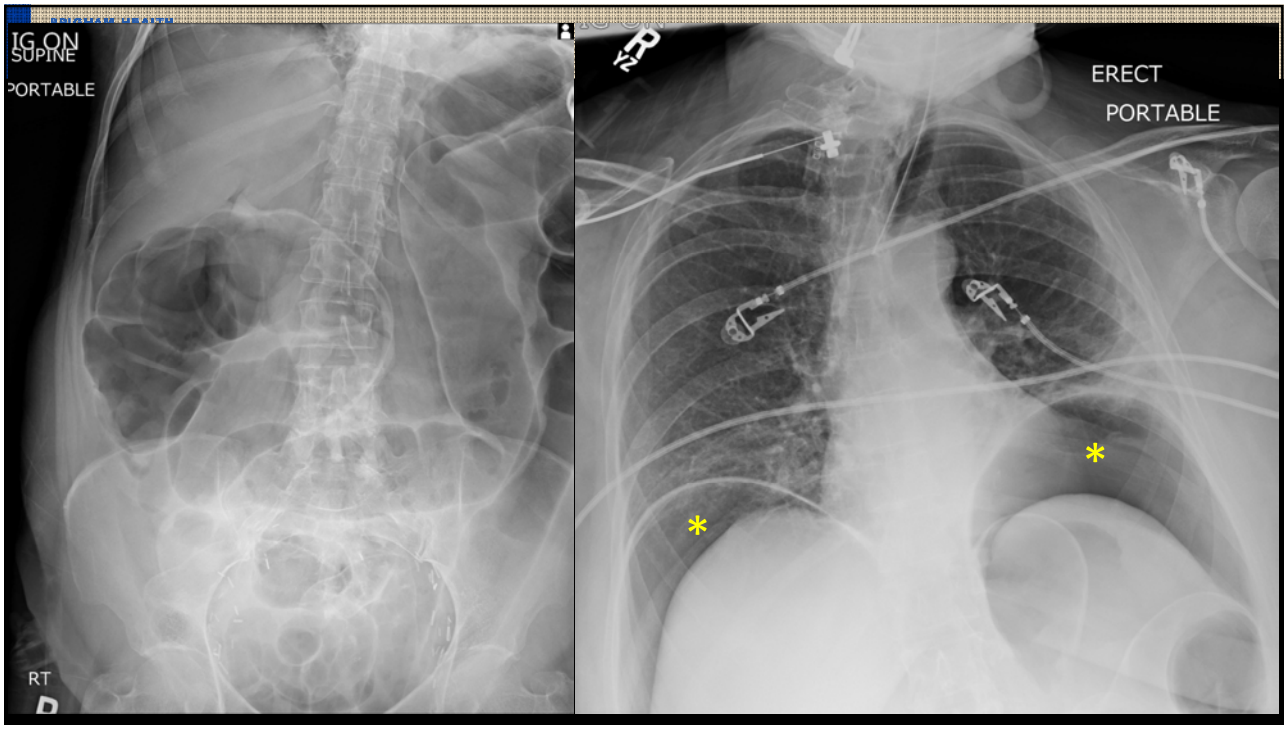


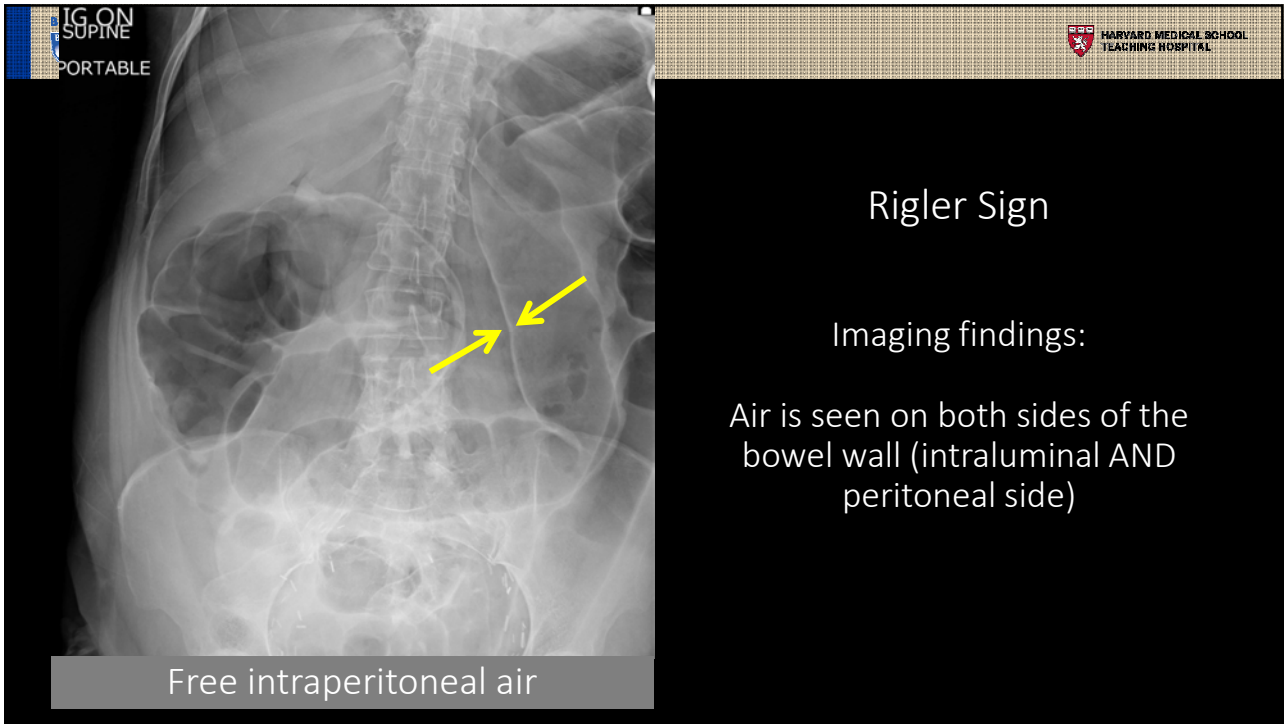
Perforated Bowel: Peptic Ulcer

One of the most common causes of perforated bowel

Free Intraperitoneal Air

- Abdominal emergency requiring surgical or percutaneous intervention
- Contained perforations can be managed conservatively
- Most common sources:
  1. Perforated diverticulitis
  2. Perforated peptic ulcers
  3. Others: perforated carcinoma, bowel ischemia
- Iatrogenic:
  - Post endoscopy, colonoscopy
  - Postoperative

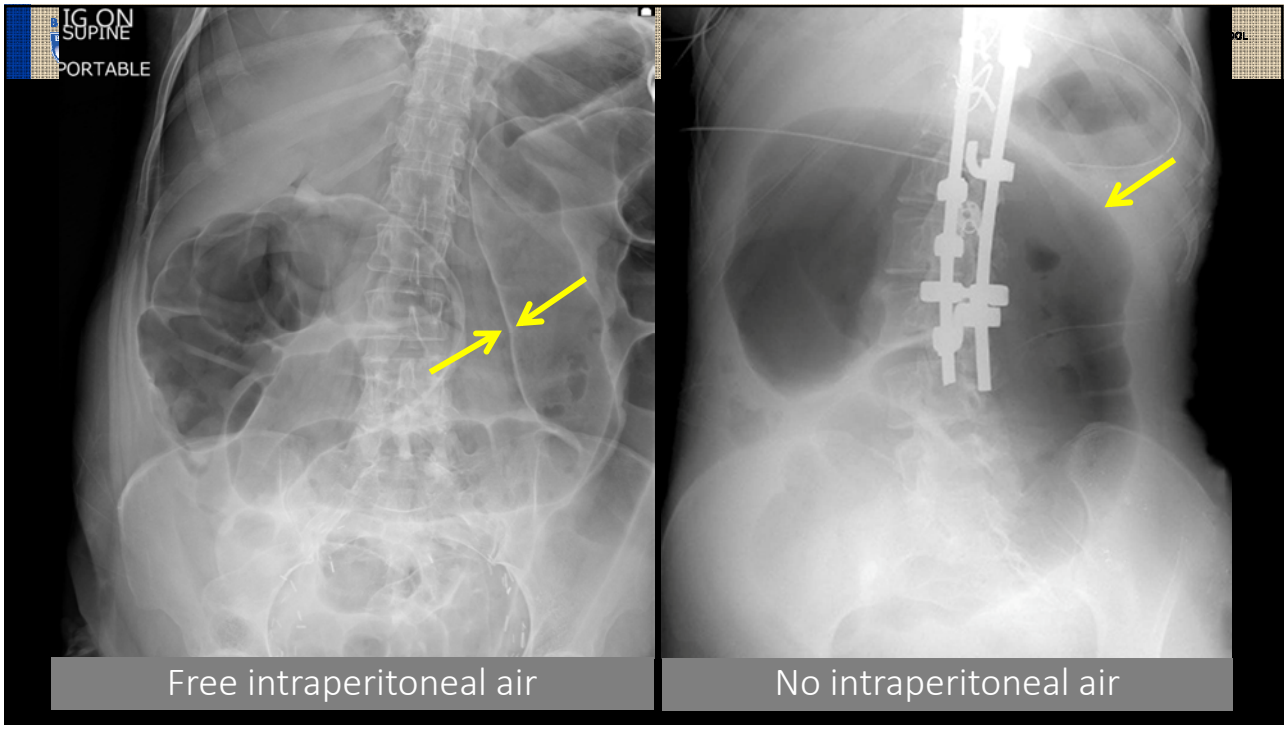


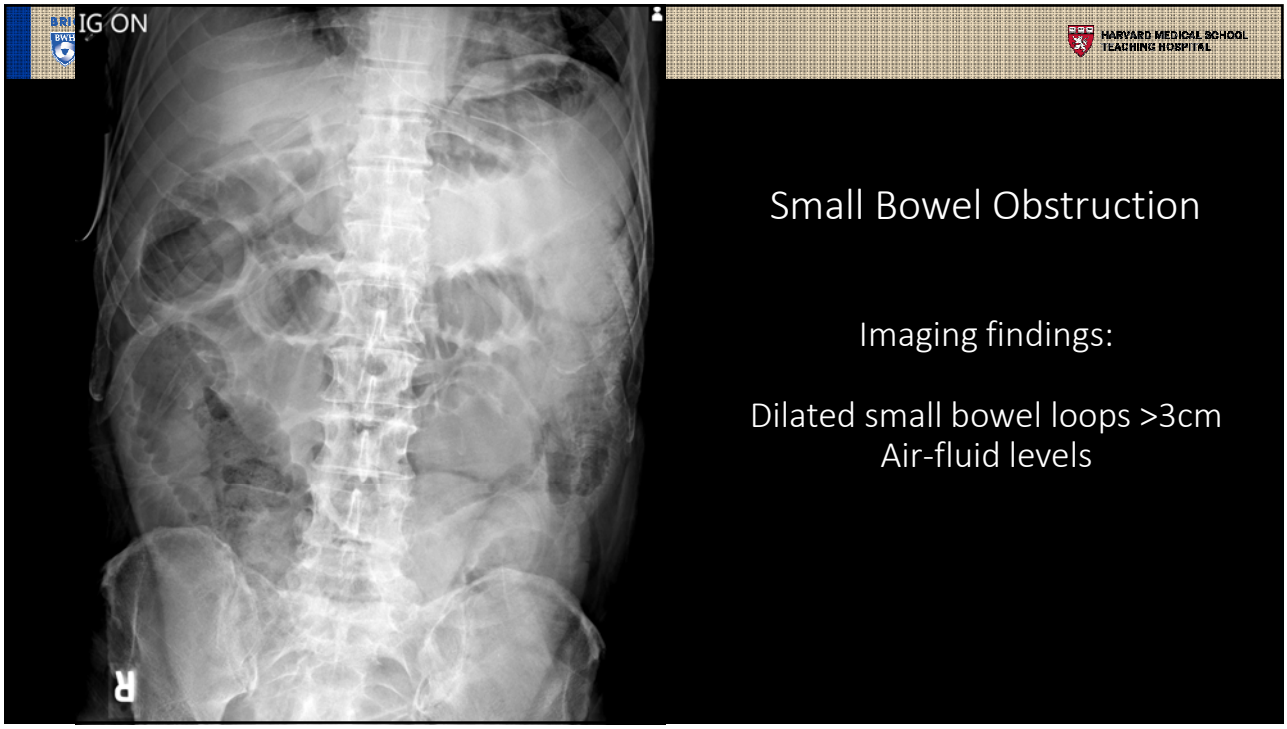


Rigler Sign

Imaging findings:

Air is seen on both sides of the bowel wall (intraluminal AND peritoneal side)


SUPINE
PORTABLE
Free intraperitoneal air
No intraperitoneal air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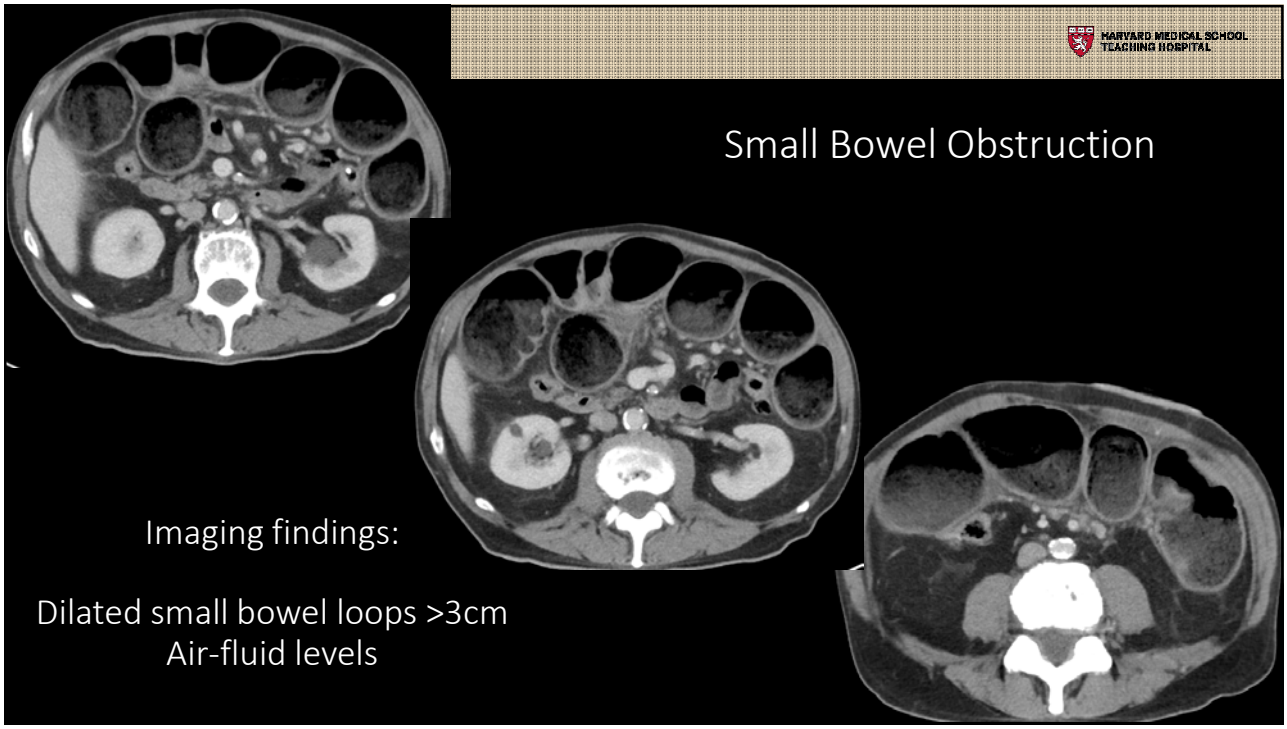
Small Bowel Obstruction
Imaging findings:
Dilated small bowel loops >3cm
Air-fluid levels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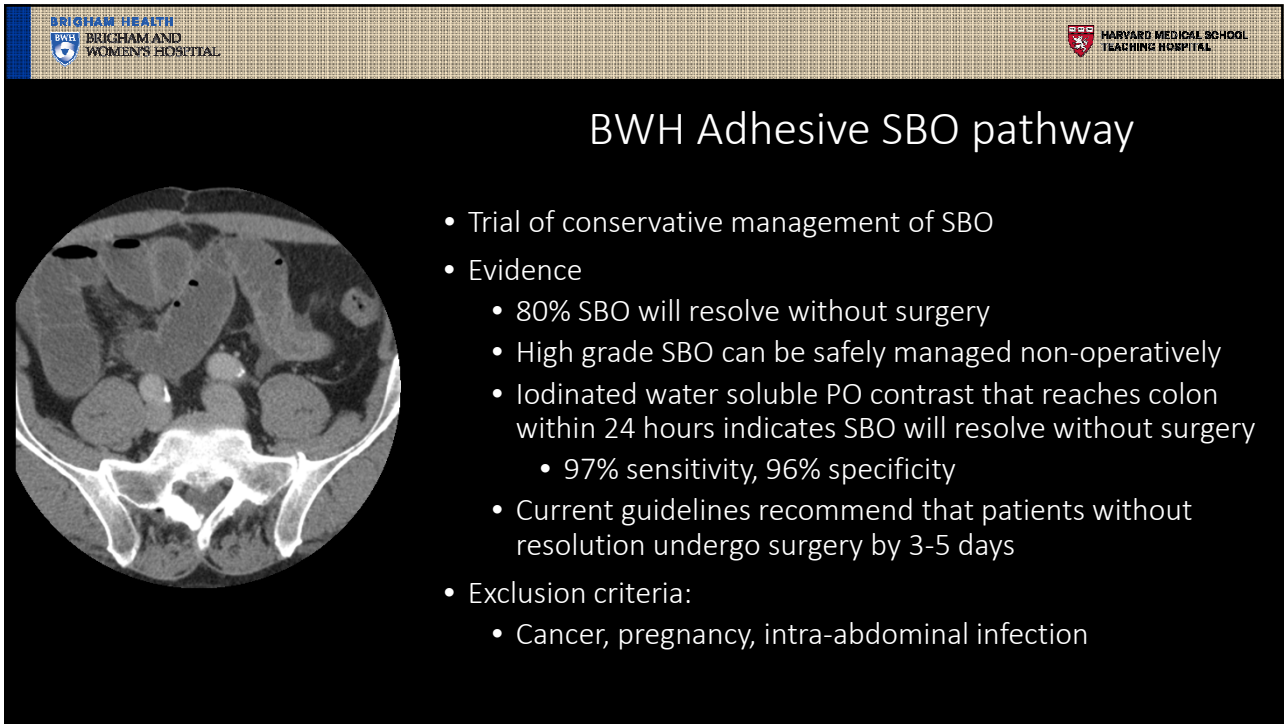
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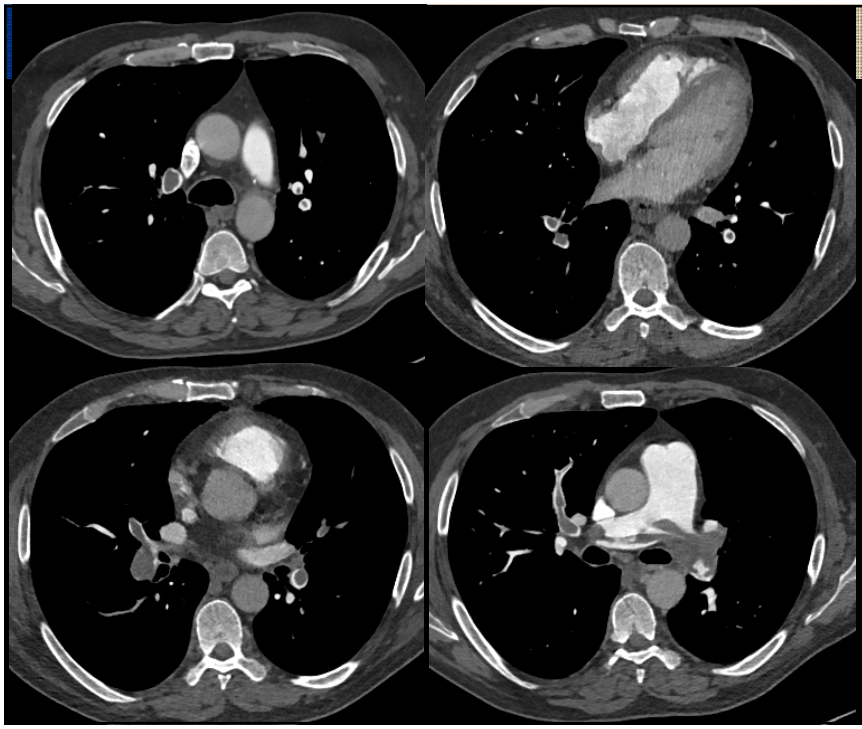
BWH Adhesive SBO pathway
• Trial of conservative management of SBO
• Evidence
• 80% SBO will resolve without surgery
• High grade SBO can be safely managed non-operatively
• Iodinated water soluble PO contrast that reaches colon within 24 hours indicates SBO will resolve without surgery
• 97% sensitivity, 96% specificity
• Current guidelines recommend that patients without resolution undergo surgery by 3-5 days
• Exclusion criteria:
• Cancer, pregnancy, intra-abdominal infection



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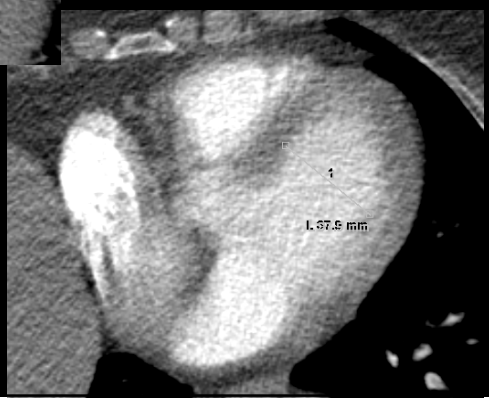
Saddle Pulmonary Embolism

Imaging findings:

Filling defects in the pulmonary arteries



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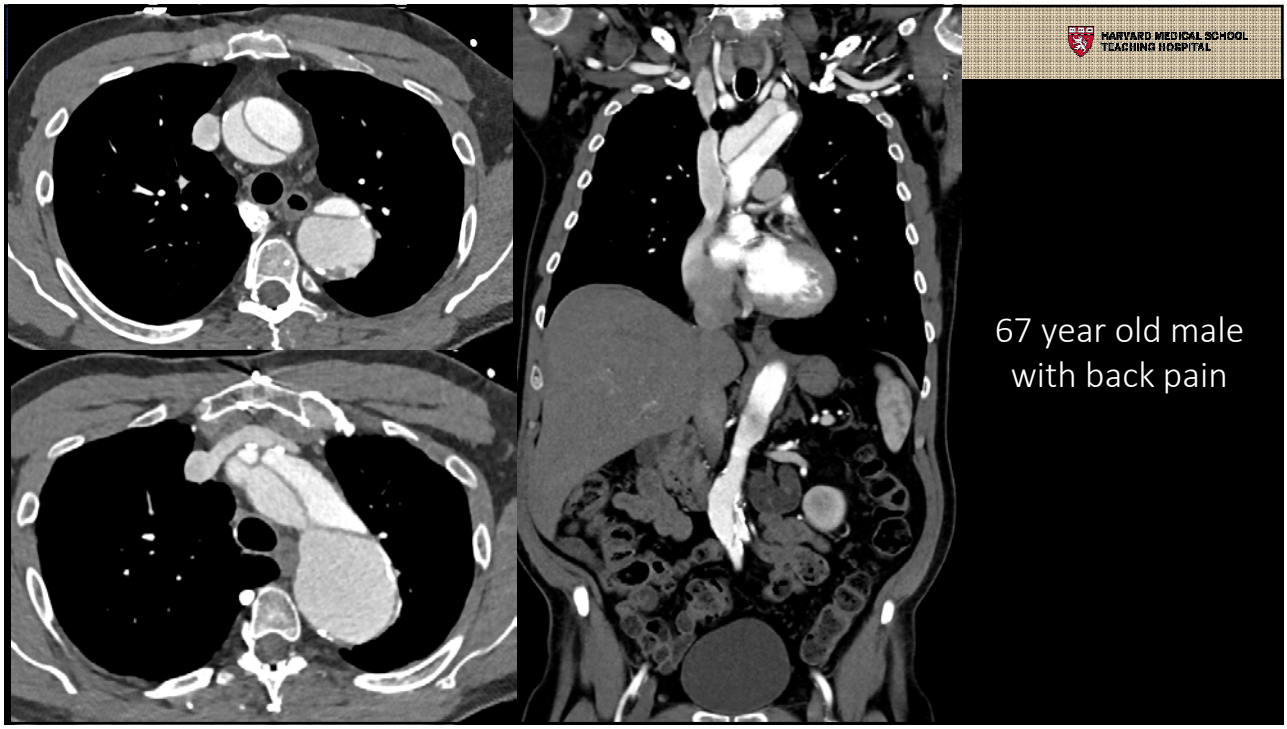
Right Heart Strain in Pulmonary Emboli

Bowing of interventricular septum

RV: LV > 1:1


HARVARD MEDICAL SCHOOL
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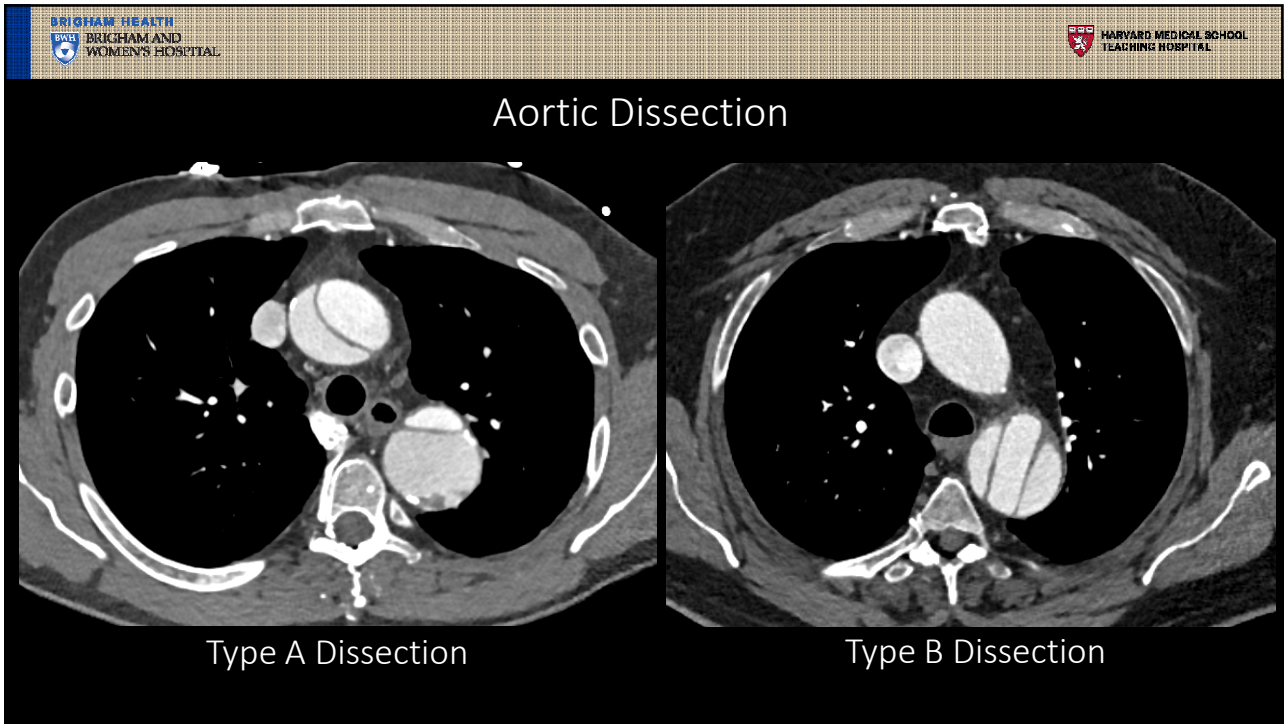
67 year old male
with back pain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HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL
Aortic Dissection
Type A Dissection
Type B Dissection

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Aortic Aneurysm Rupture

Break in wall of abdominal aortic aneurysm

- I+: AAA with active extravasation
- I-: focal discontinuity of calcification
  - High attenuation hematoma

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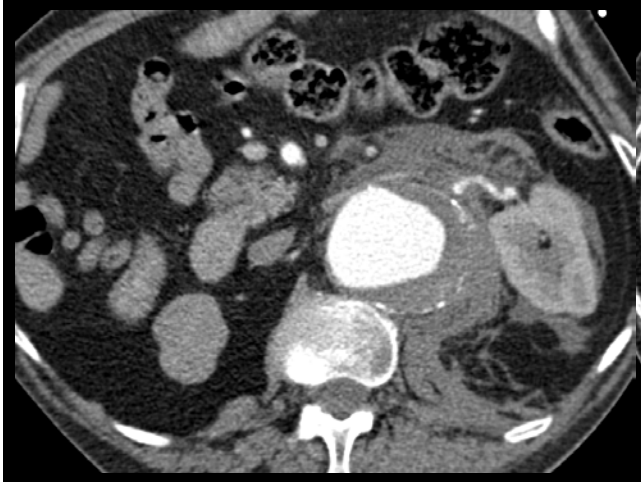

Aortic Aneurysm Rupture

Previous CTA

Subarachnoid hemorrhage

Subdural hemorrhage

Midline shift, herniation

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Part IV: Imaging Protocols and Considerations

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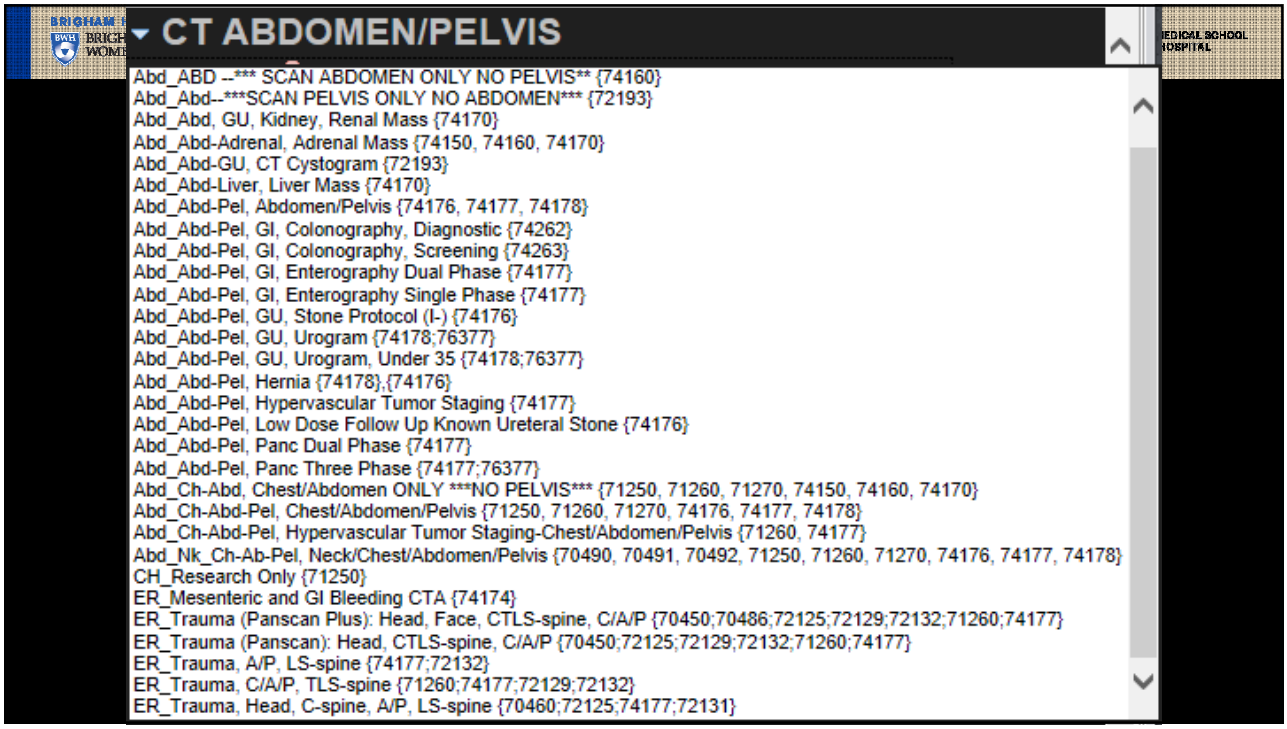
Imaging Tool Box

- Radiography/fluoroscopy
- Ultrasound (US)
- Computed tomography (CT)
- Magnetic resonance imaging (MR)
- Nuclear medicine (PET/CT, GI bleeding scan, HIDA, bone scan, etc)



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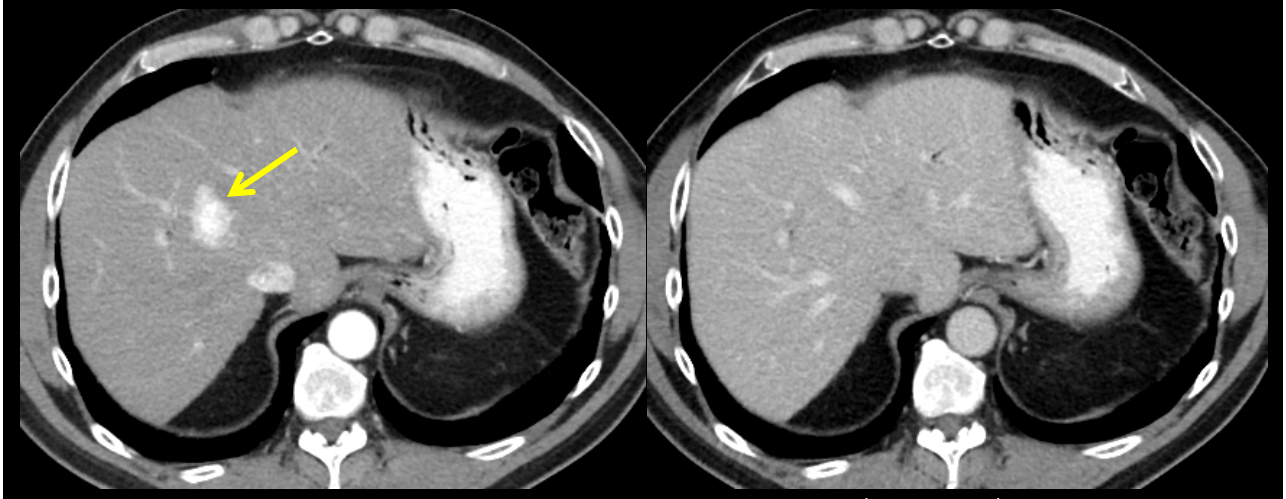
Pancreatic Neuroendocrine Tumor



Arterial Phase CT AP

Portal Venous Phase CT AP

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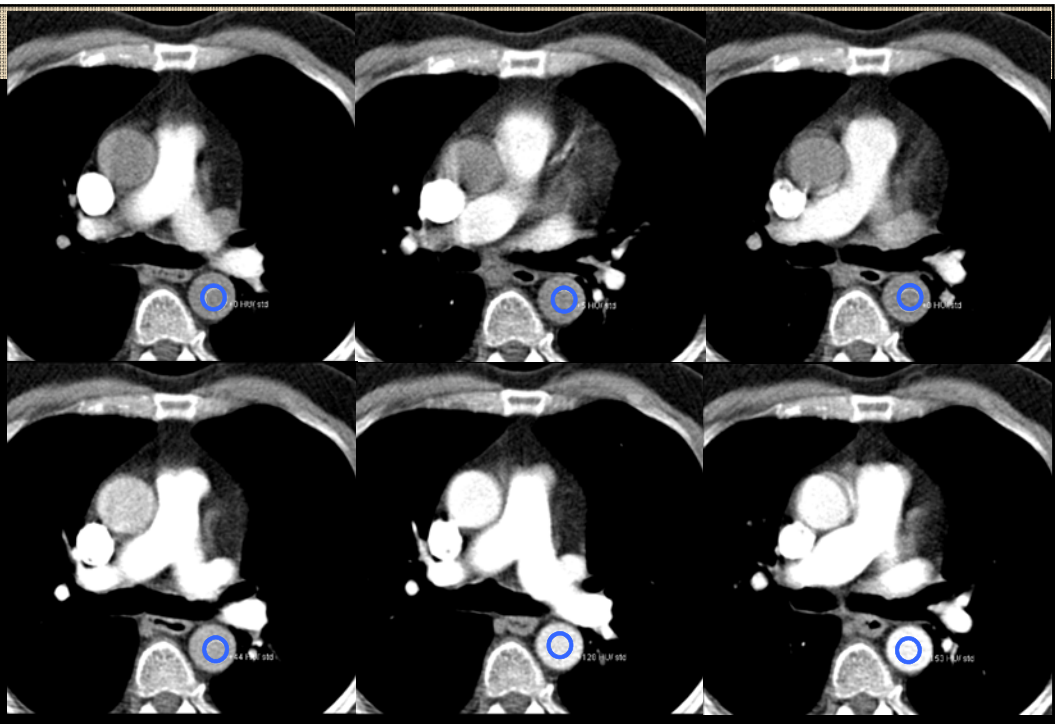
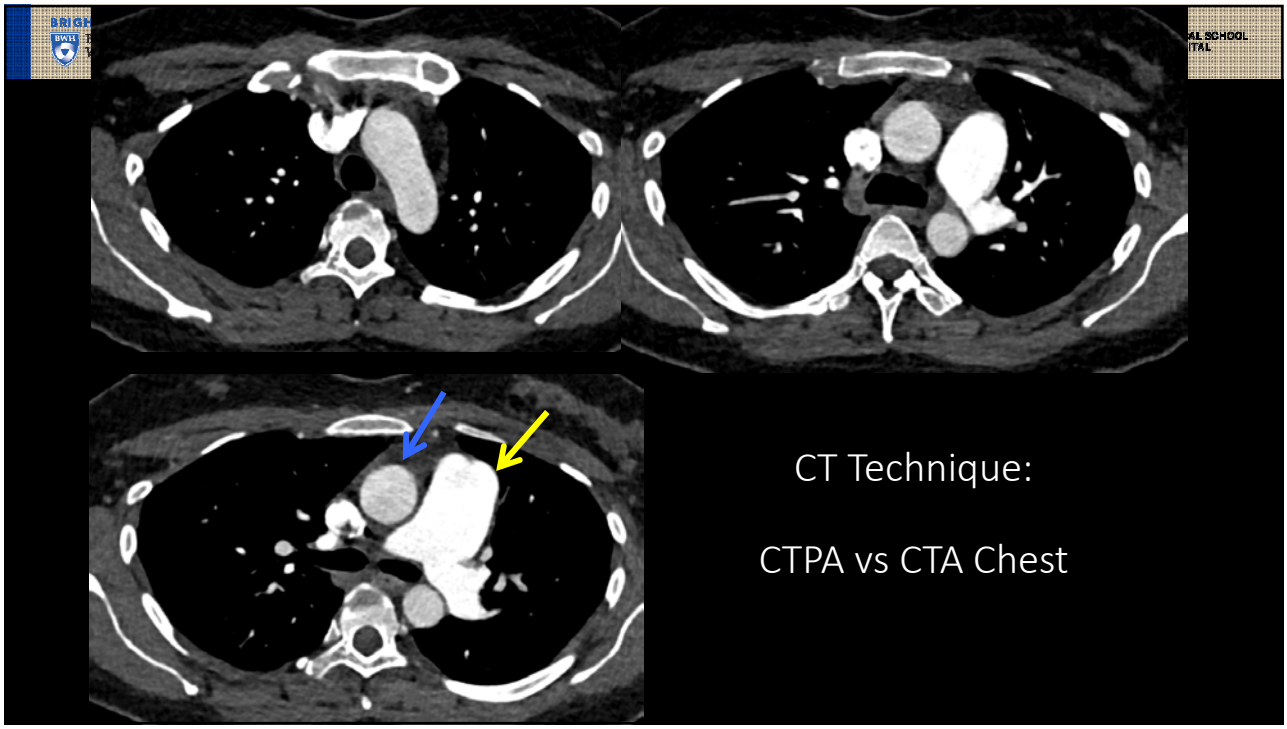
Bolus Tracking Technique





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HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

87 yo woman with HTN, CAD, diabetes, renal failure, dementia presents with severe and acute abdominal pain. Abdominal pain is maybe ?out of proportion to physical examination.

Now what?

Do I order an imaging study?

What study do I order?

US

CT

CT I-

CTA

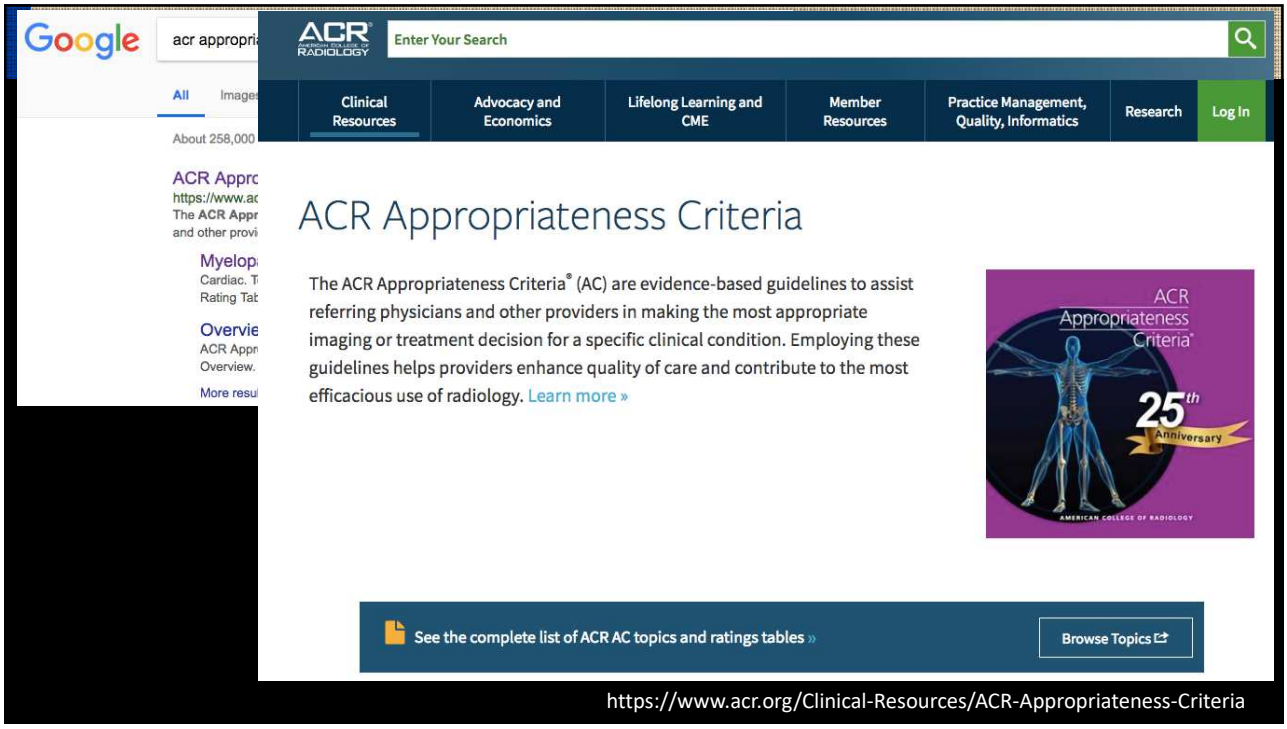
MRE

IR/Angio

ACR Appropriateness Criteria®

The ACR Appropriateness Criteria® (AC) are evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition. Employing these guidelines helps providers enhance quality of care and contribute to the most efficacious use of radiology.

https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria



https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria

Gastrointestinal				
Topic Name	Narrative & Rating Table	Evidence Table	Lit Search	Appendix
Acute Nonlocalized Abdominal Pain	Narrative & Rating Table	Evidence Table	Lit Search	Appendix
Acute Pancreatitis	Narrative & Rating Table	Evidence Table		Appendix
Blunt Abdominal Trauma	Narrative & Rating Table	Evidence Table		Appendix
Chronic Liver Disease	Narrative & Rating Table	Evidence Table	Lit Search	Appendix
Colorectal Cancer Screening	Narrative & Rating Table	Evidence Table	Lit Search	Appendix
Crohn Disease	Narrative & Rating Table	Evidence Table	Lit Search	Appendix
Dysphagia	Narrative & Rating Table	Evidence Table		Appendix
Imaging of Mesenteric Ischemia	Narrative & Rating Table	Evidence Table	Lit Search	Appendix
Jaundice	Narrative & Rating Table	Evidence Table		Appendix
Left Lower Quadrant Pain — Suspected Diverticulitis	Narrative & Rating Table	Evidence Table		Appendix
Liver Lesion — Initial Characterization	Narrative & Rating Table	Evidence Table		Appendix
Nonvariceal Upper Gastrointestinal Bleeding	Narrative & Rating Table	Evidence Table	Lit Search	Appendix
Palpable Abdominal Mass	Narrative & Rating Table	Evidence Table	Lit Search	Appendix
Pretreatment Staging of Colorectal Cancer	Narrative & Rating Table	Evidence Table	Lit Search	Appendix
Right Lower Quadrant Pain — Suspected Appendicitis	Narrative & Rating Table	Evidence Table		Appendix

https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria

American College of Radiology
ACR Appropriateness Criteria®
Imaging of Mesenteric Ischemia

Variant 1: **Suspected acute mesenteric ischemia. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CTA abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
Arteriography abdomen	May Be Appropriate (Disagreement)	☢☢☢
MRA abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	O
X-ray abdomen	May Be Appropriate	☢☢
US duplex Doppler abdomen	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
MRA abdomen and pelvis without IV contrast	Usually Not Appropriate	O

Variant 2: **Suspected chronic mesenteric ischemia. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CTA abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
MRA abdomen and pelvis without and with IV contrast	Usually Appropriate	O
Arteriography abdomen	May Be Appropriate (Disagreement)	☢☢☢
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
MRA abdomen and pelvis without IV contrast	May Be Appropriate	O
US duplex Doppler abdomen	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
X-ray abdomen	Usually Not Appropriate	☢☢

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

87 yo woman with HTN, CAD, diabetes, dementia presents with severe and acute abdominal pain. Abdominal pain is maybe ?out of proportion to physical examination.

Now what? Do I order a study? What study do I order?

CTA

Part V:
Oral and Intravenous Contrast for CT Examinations

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Evaluation of Acute Abdominal Pain in the Emergency Setting Using Computed Tomography Without Oral Contrast in Patients With Body Mass Index Greater Than 25.

Uyeda JW[1], Yu H, Ramalingam V, Devalapalli AP, Soto JA, Anderson SW.

⊕ Author information

Abstract

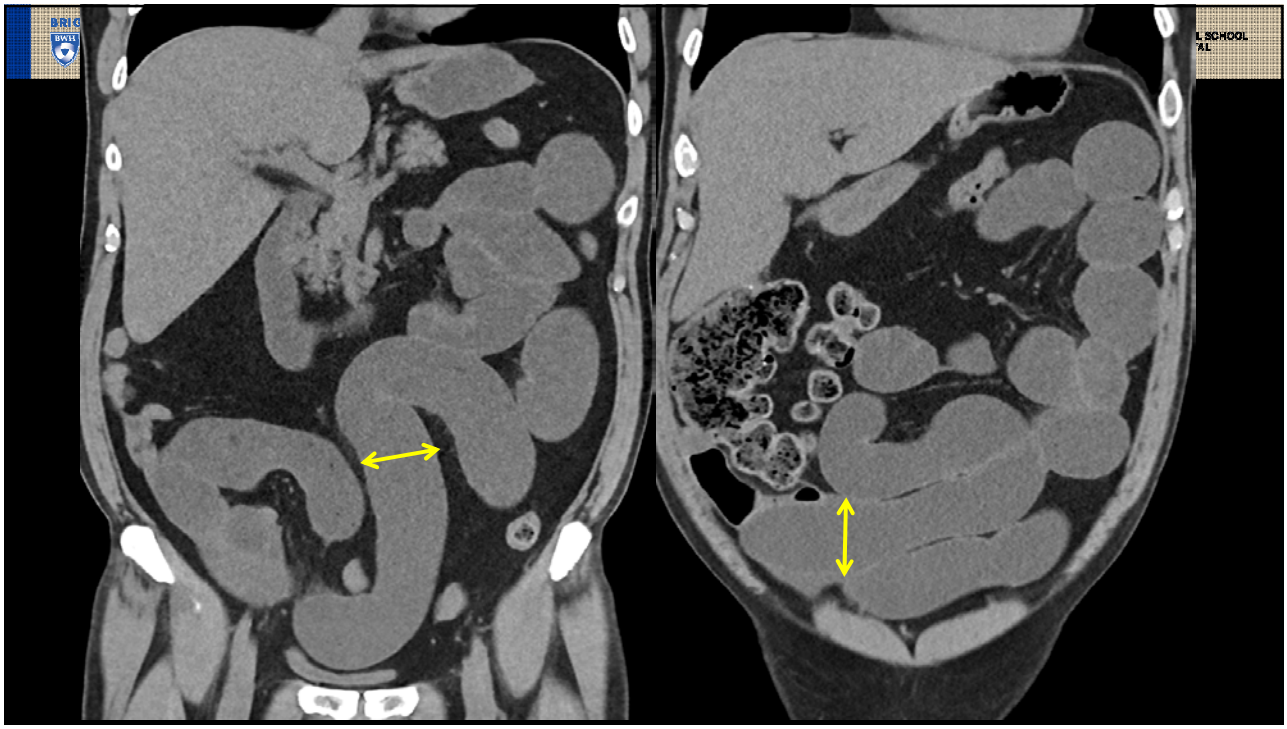
PURPOSE: To evaluate the rate of delayed or missed diagnoses and need for additional computed tomography (CT) imaging in emergency department patients with abdominal pain who are imaged without oral contrast.

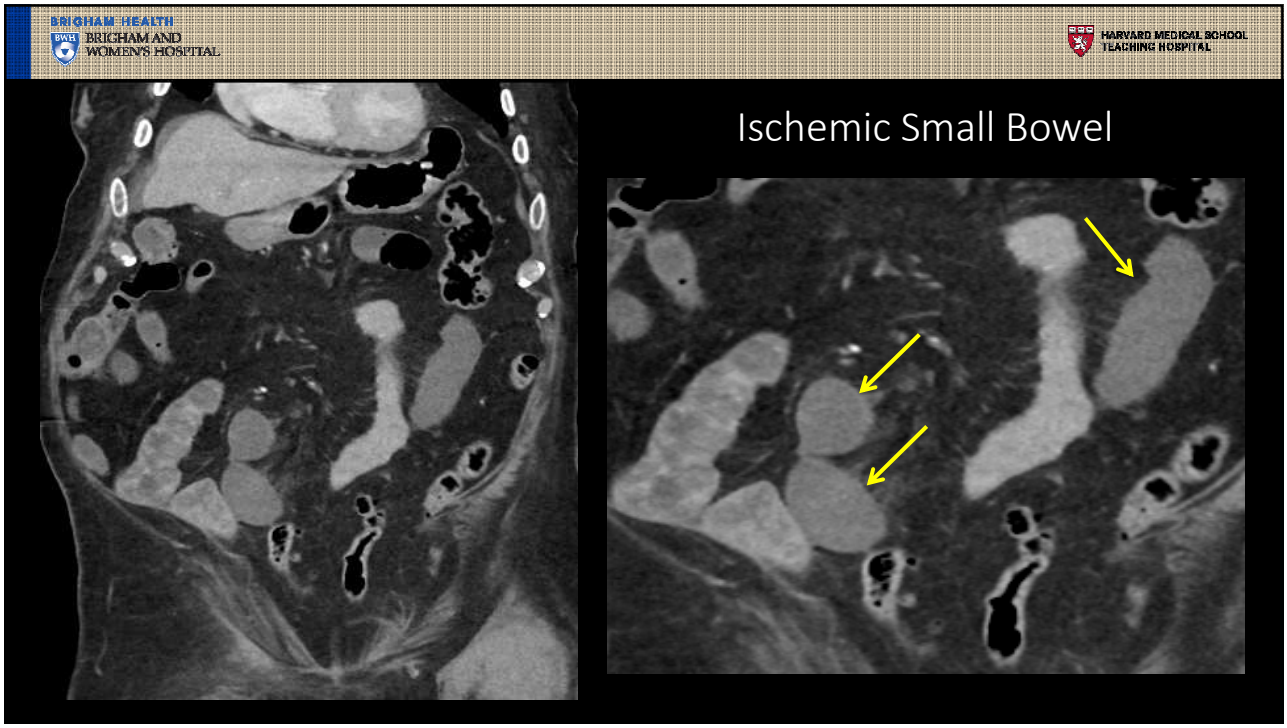
MATERIALS AND METHODS: The institutional review board approved this Health Insurance Portability and Accountability Act-compliant retrospective study; informed consent was waived. All consecutive adult patients with body mass index greater than 25 undergoing a CT abdomen/pelvis with intravenous contrast and without oral contrast with nontraumatic acute abdominal pain during a 16-month period at our academic tertiary care center were included. Medical records were reviewed, imaging findings on admission CT, use of repeat CT examinations within 4 weeks of the original examination, and clinical outcomes were recorded. In patients undergoing repeat imaging, an investigator determined whether repeat imaging was influenced by the lack of oral contrast on the original examination. As the most common cause of bowel-related positive CT scans, an analysis of acute appendicitis was performed.

RESULTS: Of the 1992 patients included in this study, 4 patients (0.2%) underwent repeat CT studies directly related to the absence of oral contrast on the original examination. Of the 1992 CT scans, 1193(59.8%) were interpreted as negative, none of which required surgery or direct intervention. In patients with acute appendicitis, there was a sensitivity of CT in this patient population of 100% with a specificity of 99.5%.

CONCLUSIONS: In patients with body mass index greater than 25 presenting to the ED with acute abdominal pain, CT examinations can be acquired without oral contrast without compromising the clinical efficacy of CT.

J Comput Assist Tomogr. 2015

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Ischemic Small Bowel

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Use of PO Contrast

- Recent postoperative patients (~30 days)
- Penetrating trauma (stab wound, GSW)
- At the request of the surgeon

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Utility of IV Contrast

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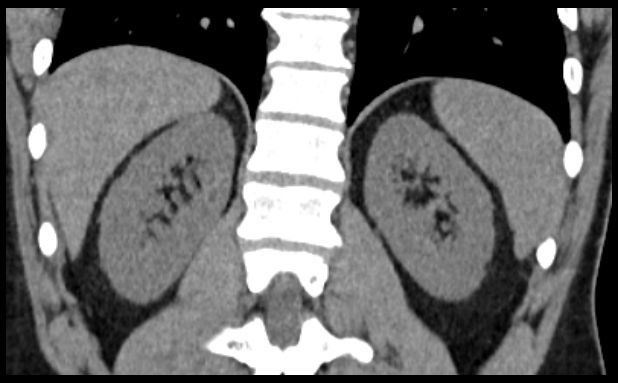

No stones or hydronephrosis

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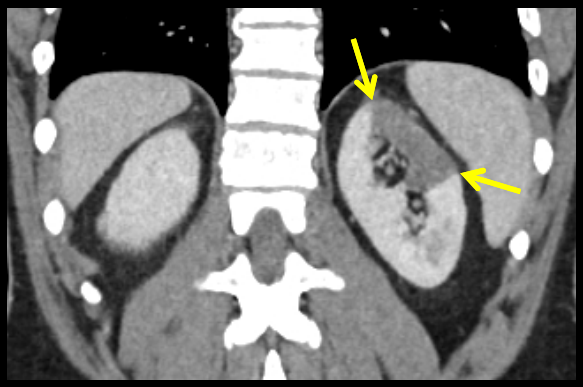

Renal infarct

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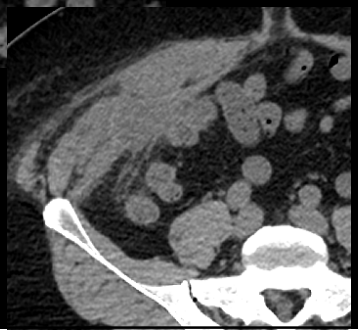
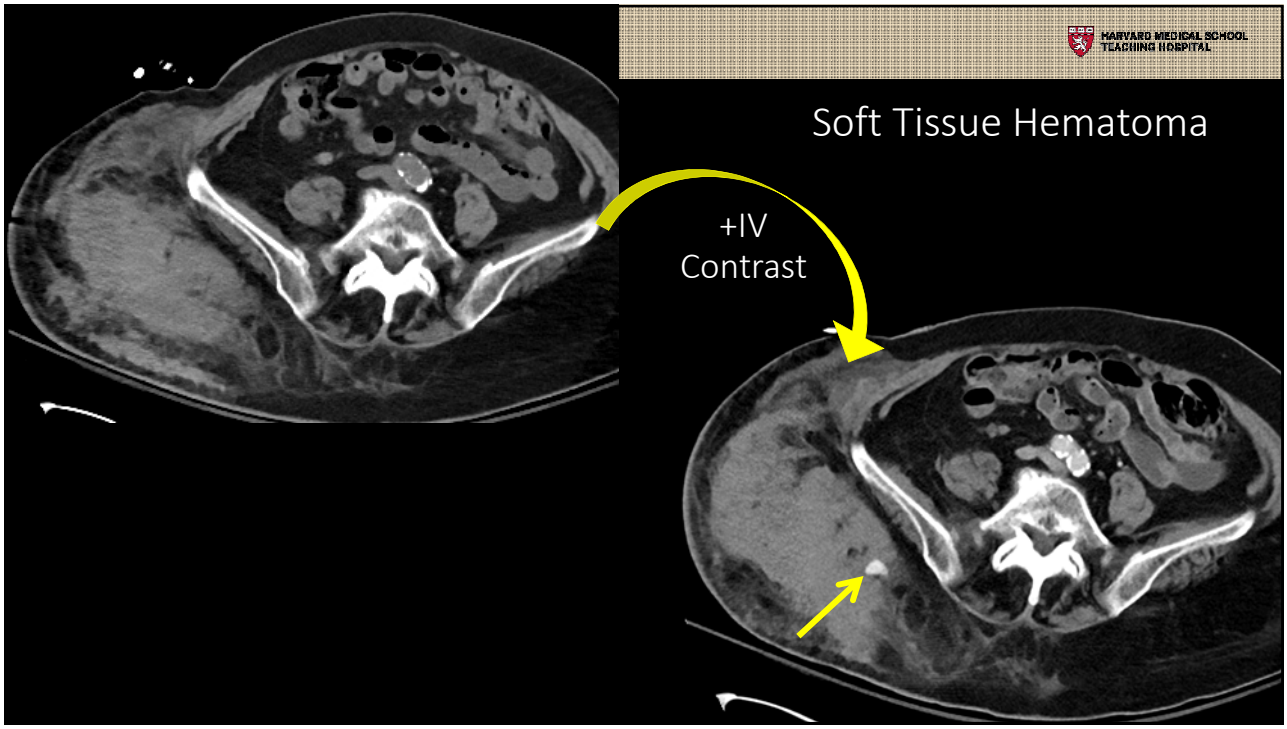
S/P Appendectomy

+IV Contrast



Anastomotic & abdominal wall abscesses


HARVARD MEDICAL SCHOOL
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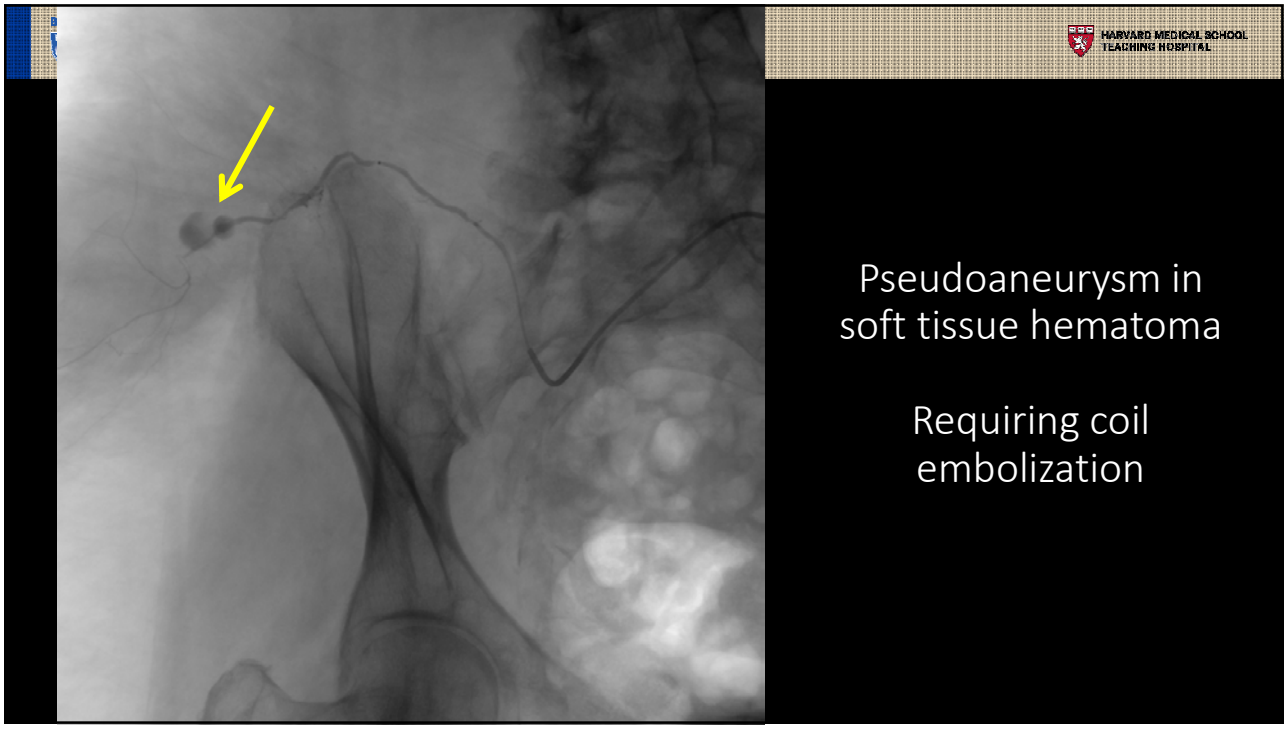
Soft Tissue Hematoma
+IV
Contrast


HARVARD MEDICAL SCHOOL
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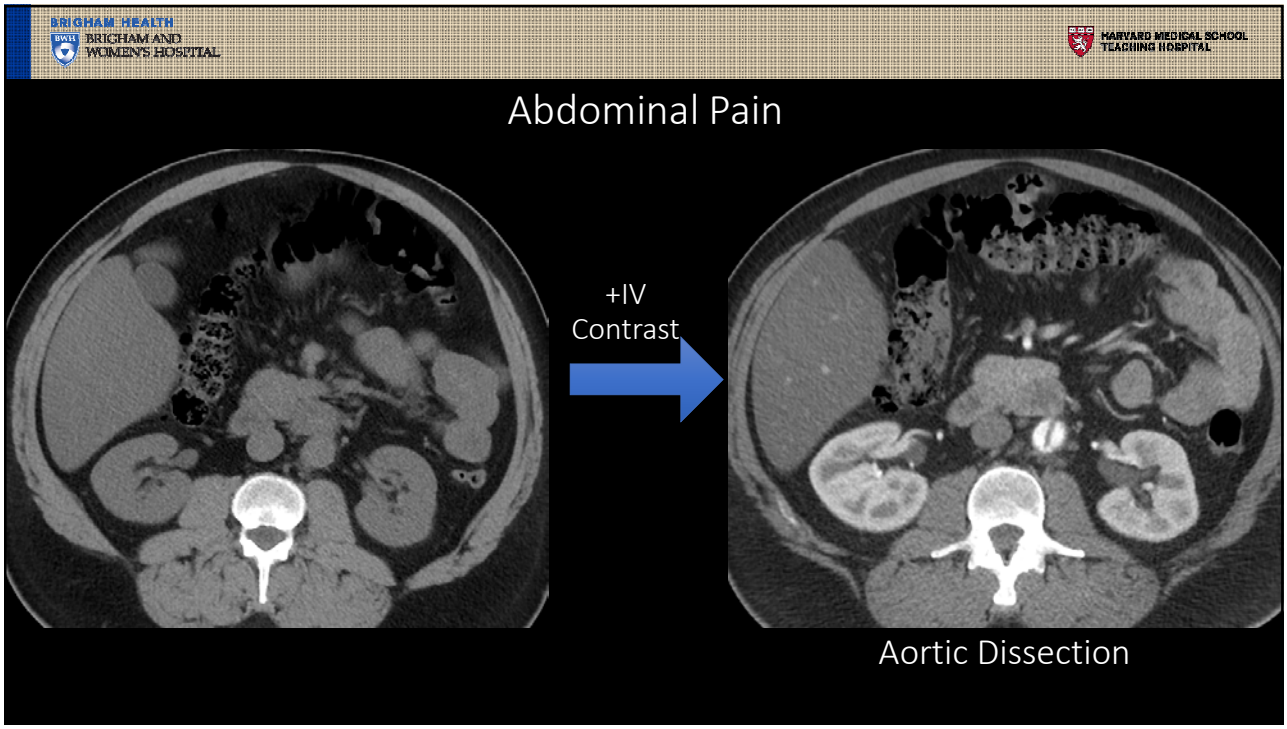
Pseudoaneurysm in
soft tissue hematoma
Requiring coil
embolization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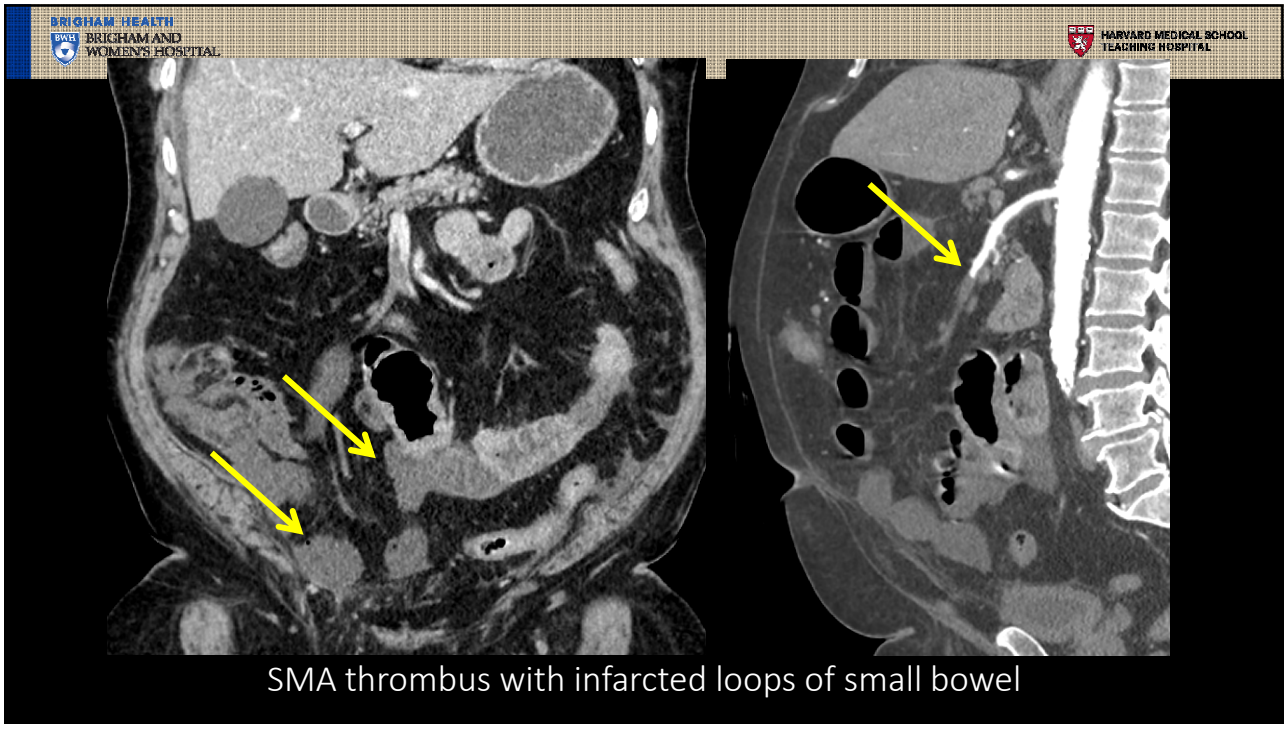
HARVARD MEDICAL SCHOOL TEACHING HOSPITAL
Abdominal Pain
+IV Contrast
Aortic Dissection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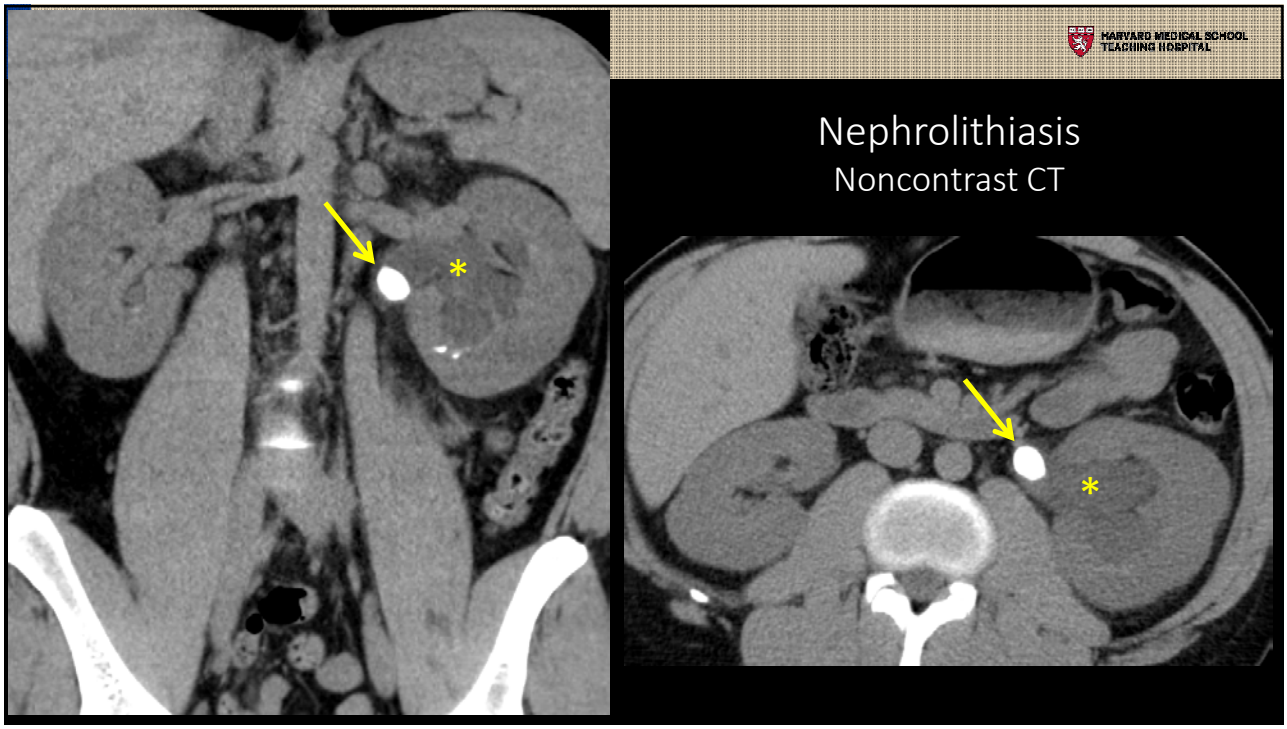
HARVARD MEDICAL SCHOOL TEACHING HOSPITAL
SMA thrombus with infarcted loops of small bowel


HARVARD MEDICAL SCHOOL
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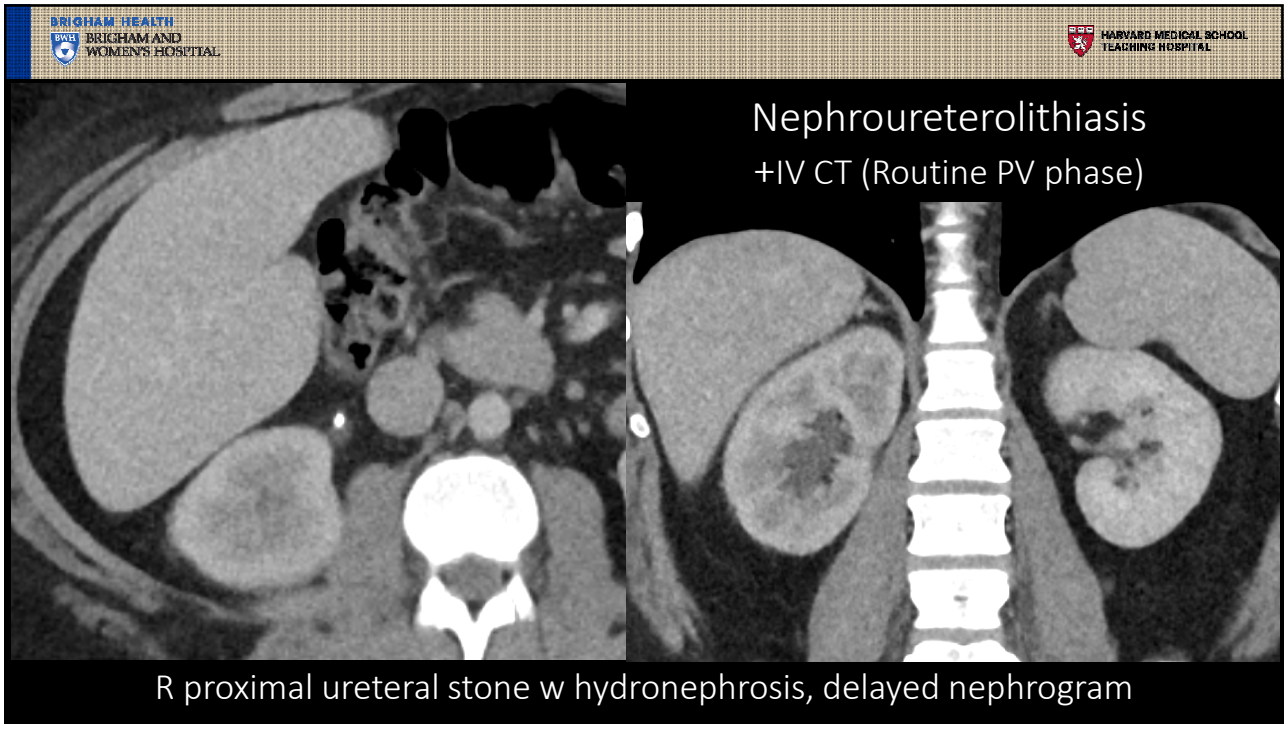
Nephrolithiasis
Noncontrast CT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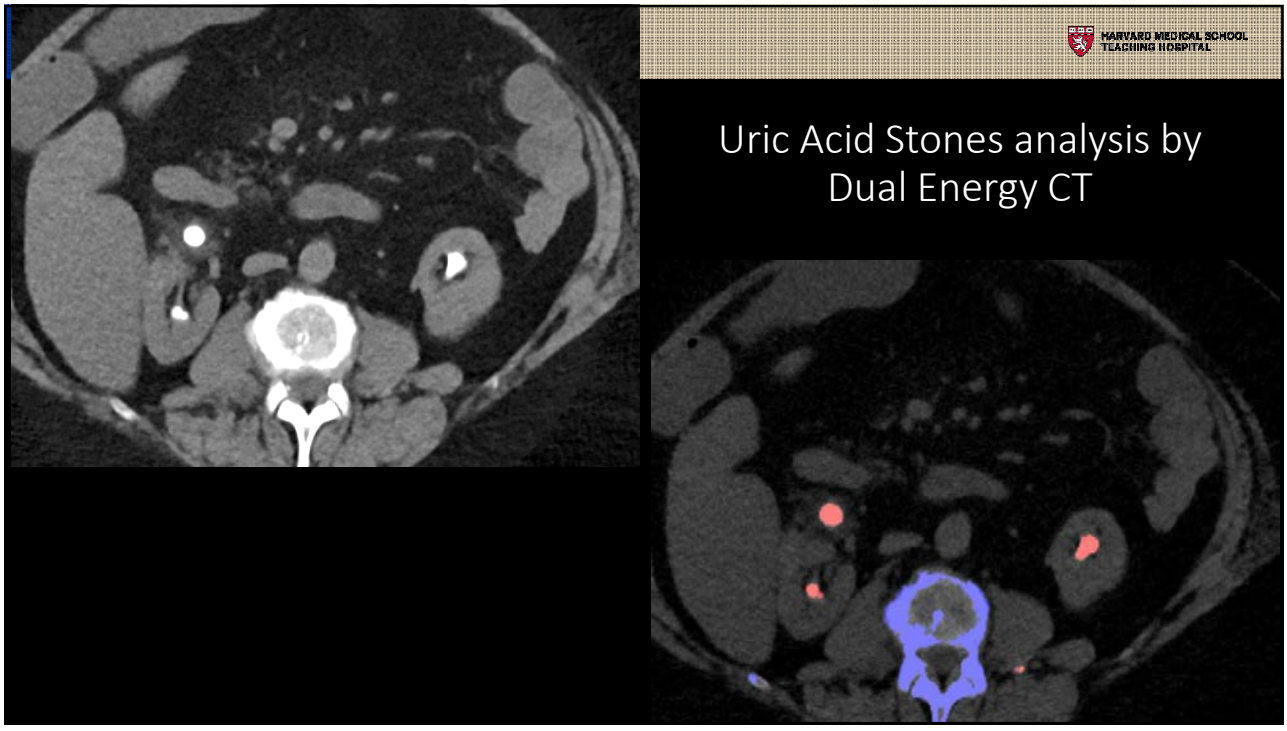
HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL
Nephroureterolithiasis
+IV CT (Routine PV phase)
R proximal ureteral stone w hydronephrosis, delayed nephrogram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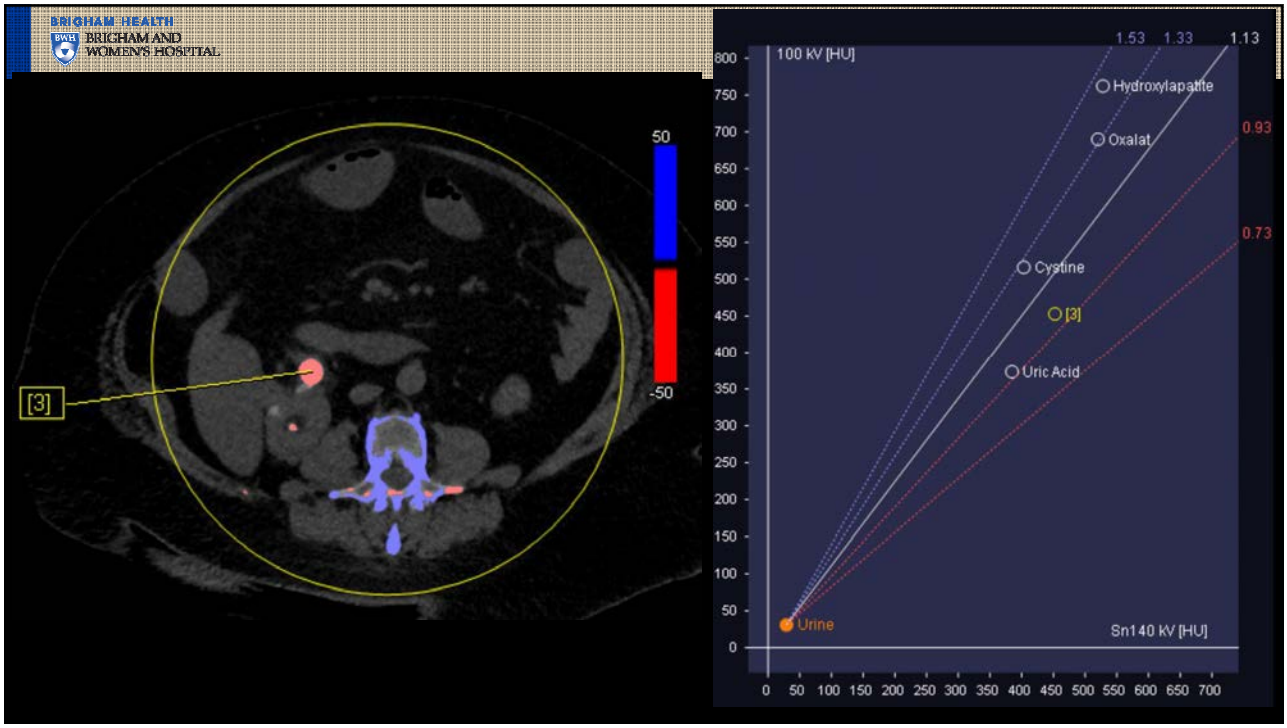
Uric Acid Stones analysis by
Dual Energy CT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50
-50
[3]
100 kV [HU]
1.53
1.33
1.13
Hydroxylapatite
Oxalat
0.93
0.73
Cystine
[3]
Uric Acid
Urine
Sn140 kV [HU]
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
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0 50 100 150 200 250 300 350 400 450 500 550 600 650 700

Part VI: Renal Failure and Contrast Allergies

www.acr.org/Clinical-Resources/Contrast-Manual

Contrast-Induced Nephropathy

- "At the current time, it is the position of ACR Committee on Drugs and Contrast Media that CIN is a real, albeit rare, entity."
- Literature fails to include control group
- Studies done on cardiac angiography patients → overestimate CIN risk
- Threshold eGFR ≥ 30 mL/min/1.73m^2

Risk Factors Warranting Renal Function Assessment

- Age > 60
- History of renal disease, including:
  - Dialysis
  - Renal cancer
  - Kidney transplant
  - Single kidney
  - Renal surgery
- History of hypertension requiring medical therapy
- History of diabetes mellitus
- Metformin or metformin-containing drug combinations

*Patients scheduled for routine intravascular study but do NOT have one of the above risk factors do NOT require a baseline serum creatinine determination before iodinated contrast medium administration.

www.acr.org/Clinical-Resources/Contrast-Manual

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Dialysis Patients

- Patients with anuric end-stage renal disease who do not have functioning transplant can receive IV contrast
- Theoretical risk of converting oliguric patient on dialysis to anuric patient but remains speculative
- Low-osmolality contrast is readily cleared by dialysis. Unless unusually large volume of contrast is given, or there is substantial underlying cardiac dysfunction, there is NO need for urgent dialysis after contrast

www.acr.org/Clinical-Resources/Contrast-Manual

Allergic Reactions

- Hydrocortisone-based: 5 hour prep (Inpatient & ED pts)
  - 200 mg IV hydrocortisone 5 hours before contrast AND
  - 200 mg IV hydrocortisone + 50 mg diphenhydramine 1 hour prior

OR

- Prednisone-based: 13 hour prep (outpatient)
  - 50 mg PO prednisone 13 and 7 hours before AND
  - 50 mg PO prednisone + 50 mg diphenhydramine IV, IM, or PO 1 hour before

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Multiple Contrast Injections

- No guidelines preclude multiple contrast injections in 24 hour period
- Confirm that ordered IV contrast study is needed
- Small risk of renal failure
- Borderline eGFR (<30-45): consider hydration with normal saline
  - 100 mL/hr for 1 hour and 4 hours following scan
  - Total 500 mL

Allergic Reactions

- Premedication does not prevent all reactions
- Has not been confirmed to reduce moderate to severe reactions or reaction-related deaths
- Limited supporting efficacy in high-risk patients
- History of prior severe contrast reaction is considered a relative contraindication
- Rare situations where urgency of contrast study may outweigh benefits of prophylaxis → must be made jointly by radiology, referring service, and the patient (if feasible) and resuscitation team should be available

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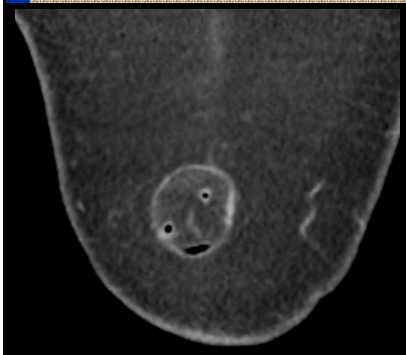
Lecture Summary

- Interpret basic chest radiographs
- Recognize and locate various tubes and lines
- Identify "can't miss radiology diagnoses" on plain x-ray and CT
- Discuss various imaging protocols and considerations
- Recognize the pros and cons of IV and PO contrast use in CT
- Optimally triage renal failure and contrast allergy patients



Thank you!

juyeda@bwh.harvard.edu