BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

Financial Disclosures

- None

BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

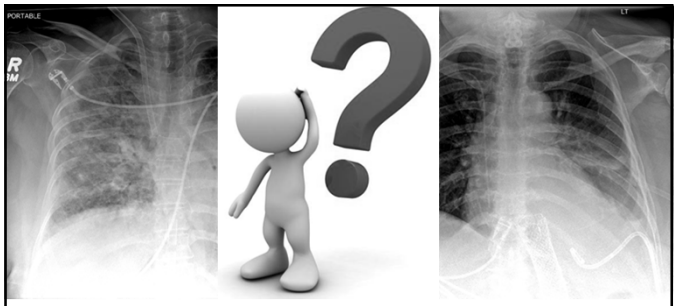
Lecture Outline

- Over the next 50 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

BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

Part I: Interpreting chest radiographs



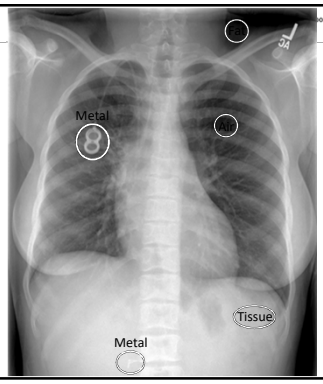
"Opacities could represent atelectasis, pleural effusion, or pulmonary edema, however, airspace disease/pneumonia cannot be excluded."

BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL

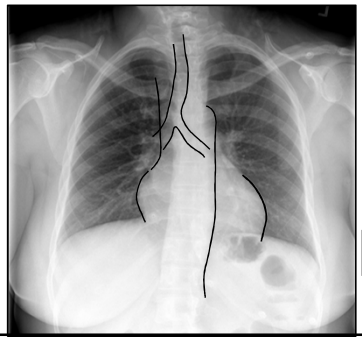
Conventional Radiographs

- Four basic tissue densities
  1. Air
  2. Fat
  3. Tissue (water)
  4. Metal (bone)

#1



Normal Chest Radiograph



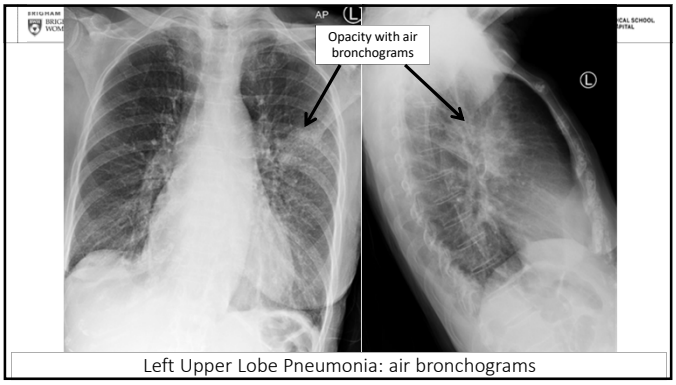
Right paratracheal stripe: SVC

Right heart border: Right atrium

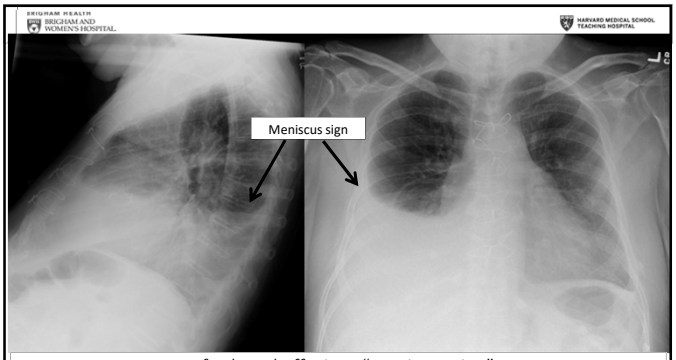
Trachea

Aortic knob and descending thoracic aorta

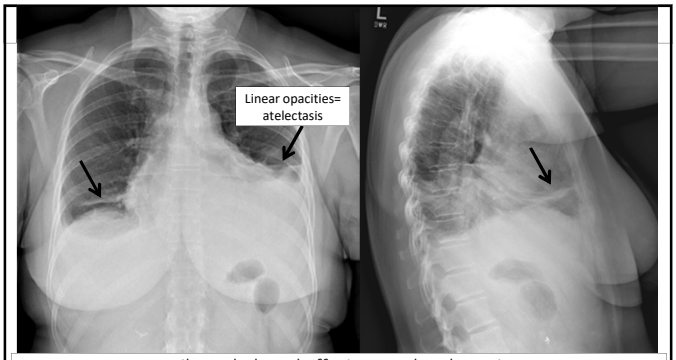
Left heart border: left ventricle



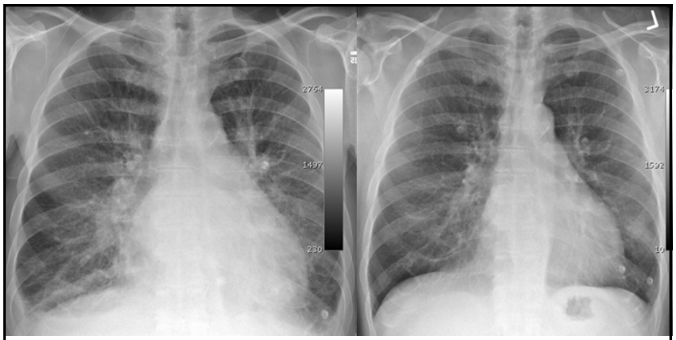
Left Upper Lobe Pneumonia: air bronchograms



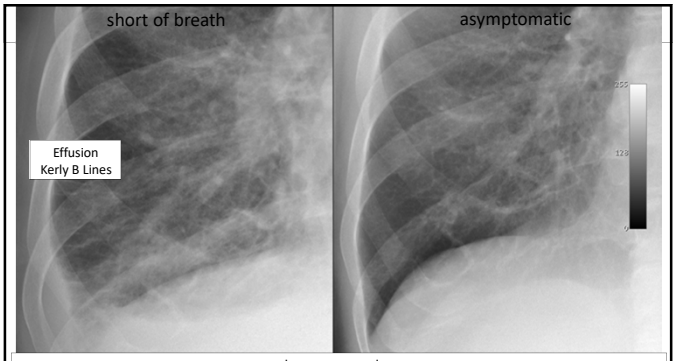
Left pleural effusion: “meniscus sign”



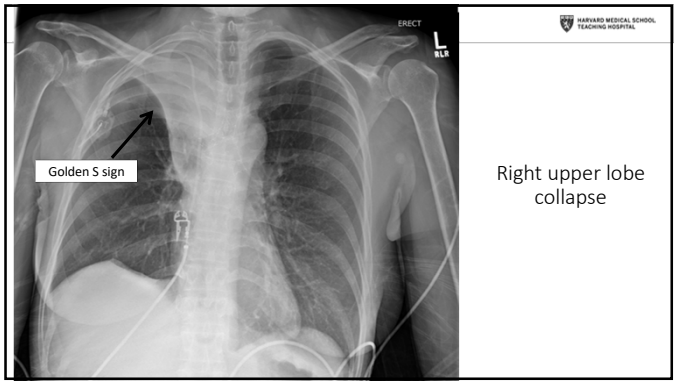
Bilateral pleural effusions and atelectasis



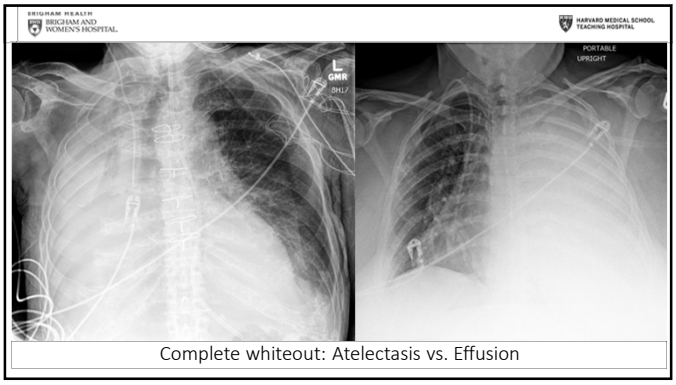
short of breath asymptomatic



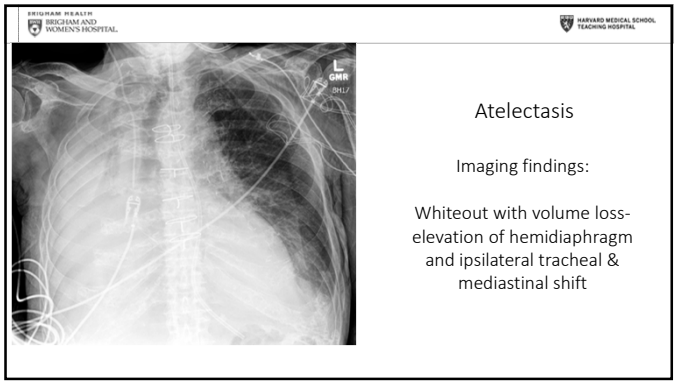
Pulmonary edema



Right upper lobe collapse



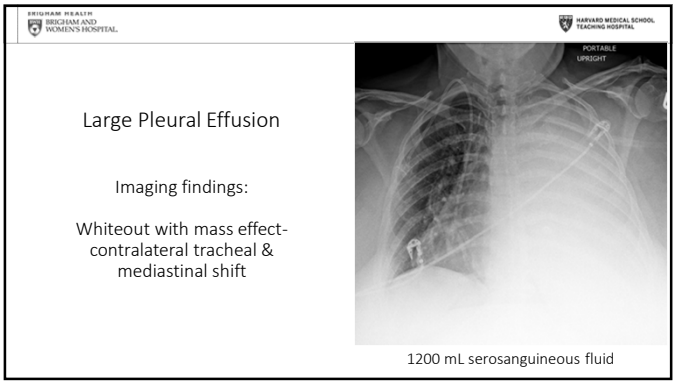
Complete whiteout: Atelectasis vs. Effusion



Atelectasis

Imaging findings:

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

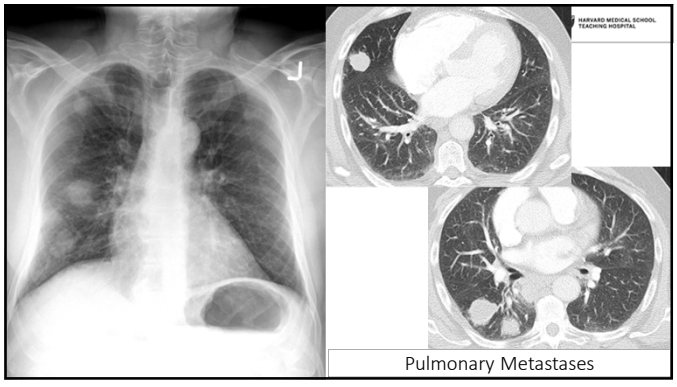


Large Pleural Effusion

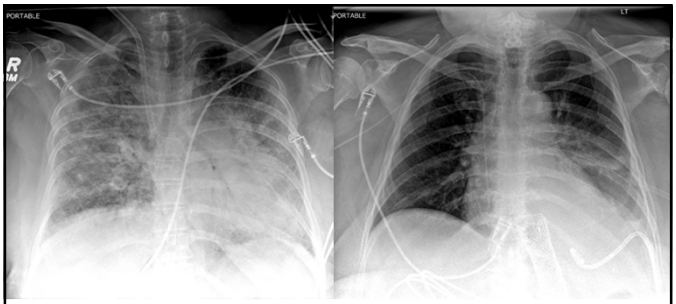
Imaging findings:

Whiteout with mass effect-contralateral tracheal & mediastinal shift

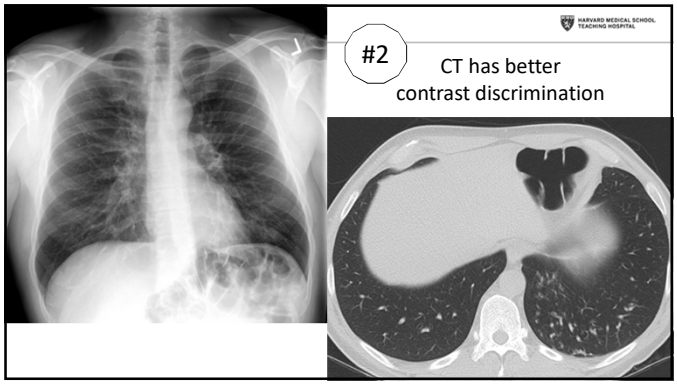
1200 mL serosanguineous fluid



Pulmonary Metastases

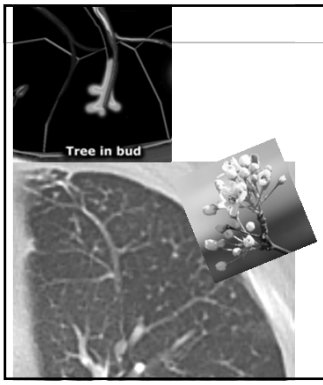


"Opacities could represent atelectasis, pleural effusion, or pulmonary edema, however, airspace disease/pneumonia cannot be excluded."



#2

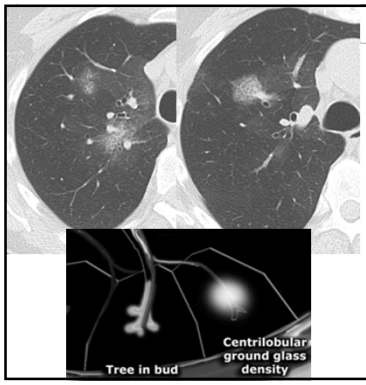
CT has better contrast discrimination



"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

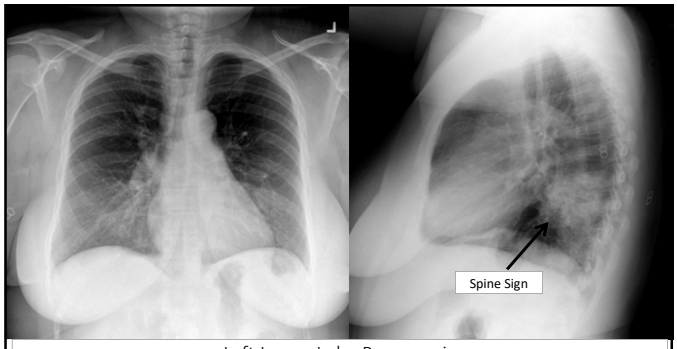


"Ground Glass" Opacities

- Increased lung attenuation without obscuring underlying vessels
- Replacement of air in alveoli by
  - Fluid (pus, edema, hemorrhage),
  - Cells (tumor),
  - Fibrosis

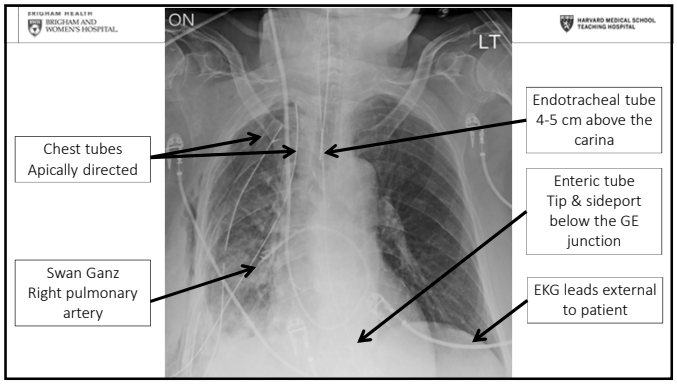
#3

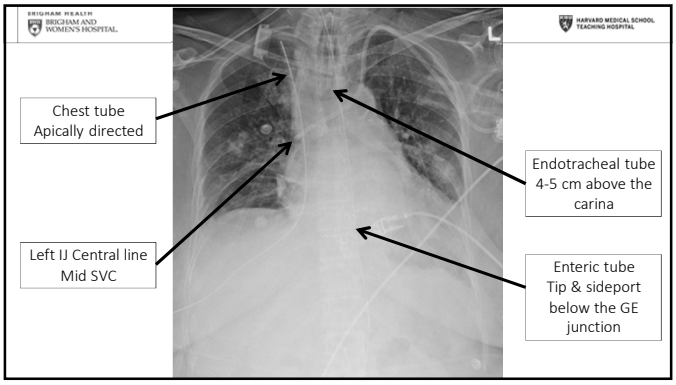
One View is No View

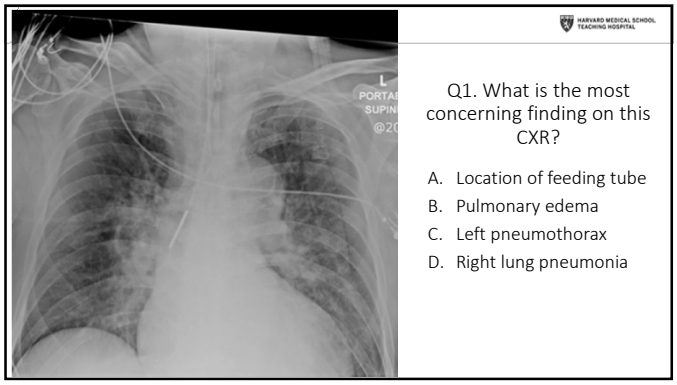


Left Lower Lobe Pneumonia

Part II: Tubes and Lines

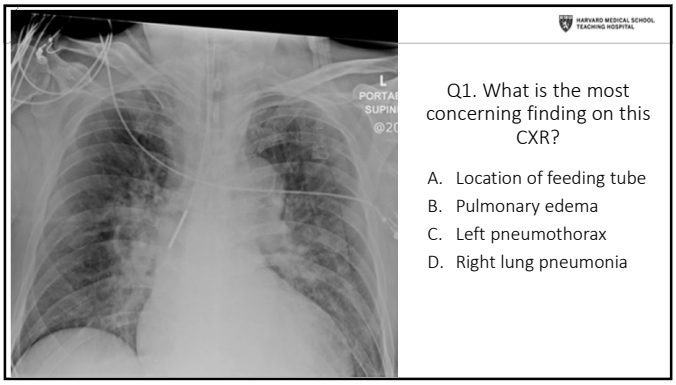






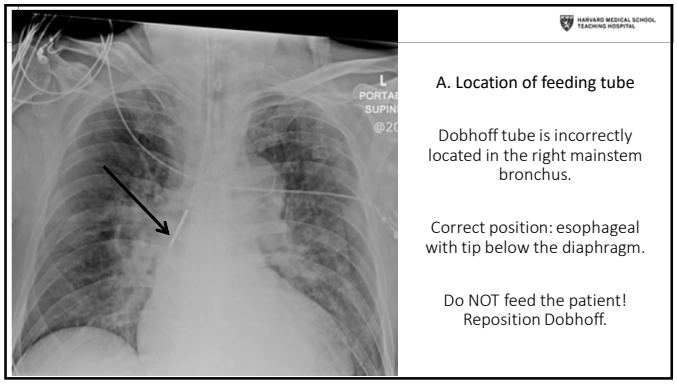
Q1. What is the most concerning finding on this CXR?

A. Location of feeding tube
B. Pulmonary edema
C. Left pneumothorax
D. Right lung pneumonia



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

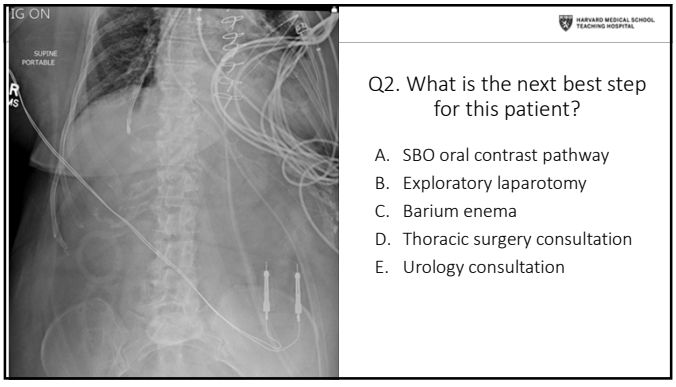


A. Location of feeding tube

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.



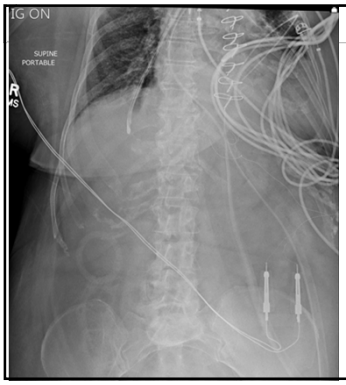
Q2. What is the next best step for this patient?

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

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

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

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!

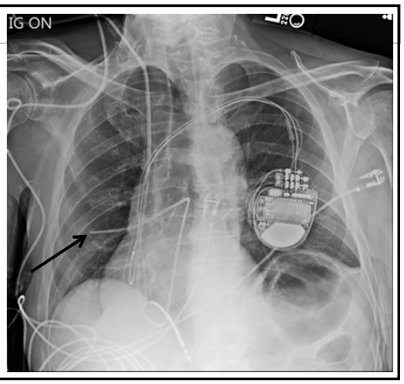
Distal position of the Dobhoff may have perforated small bronchiole and could cause a tension pneumothorax upon removal

BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL

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

Correct position: Proximal right pulmonary artery.

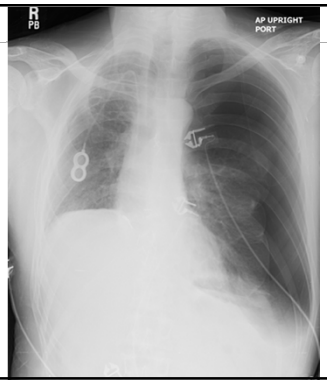
Retract catheter.



BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

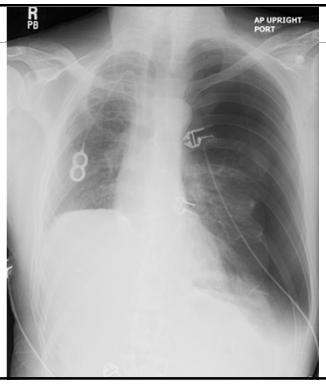
Part III: Can't Miss Radiology Diagnoses



HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

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

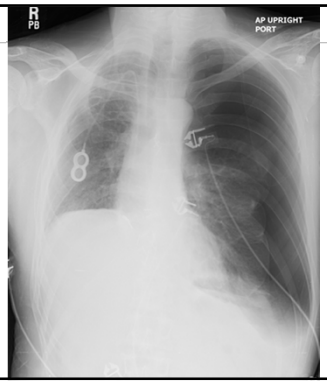
A. Location of Port catheter
B. Left pleural effusion
C. Left pneumothorax
D. Tension pneumothorax



HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

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



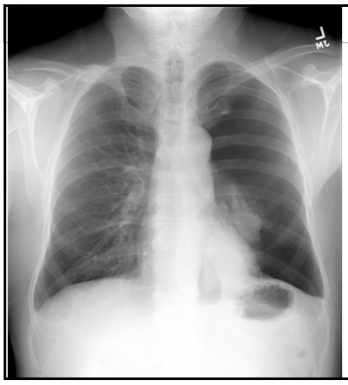
HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

D. Tension Pneumothorax

Imaging findings:

Pneumothorax with

Ipsilateral increased intercostal spaces
Contralateral mediastinal shift
Depression of diaphragm

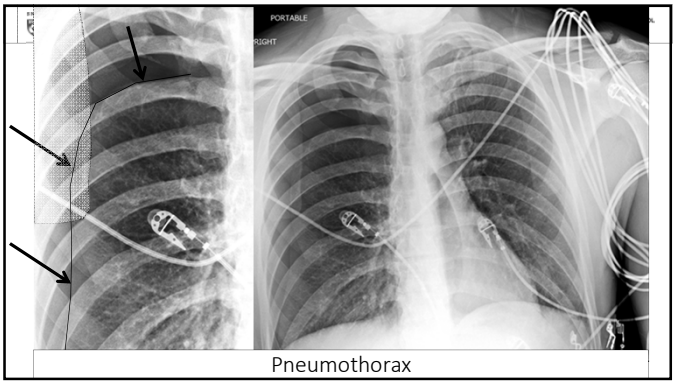


HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

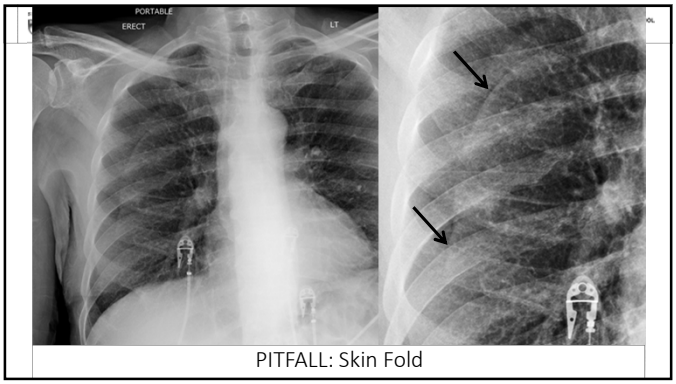
Left pneumothorax

Imaging findings:

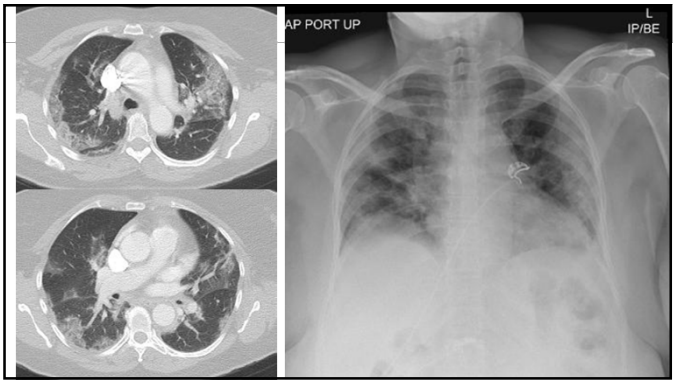
Absent lung markings
Visceral pleural line
Peripheral space is lucent
Lung may be collapsed

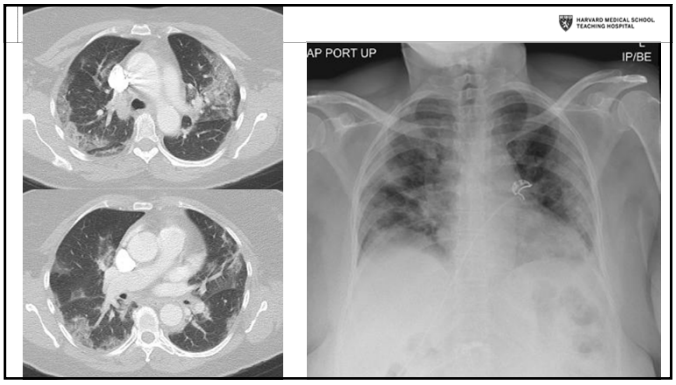


Pneumothorax



PITFALL: Skin Fold





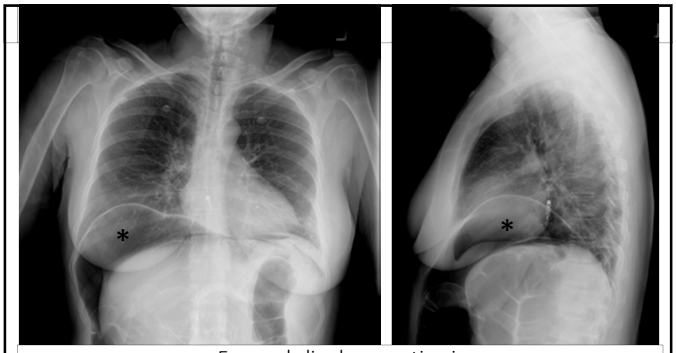
HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL
HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

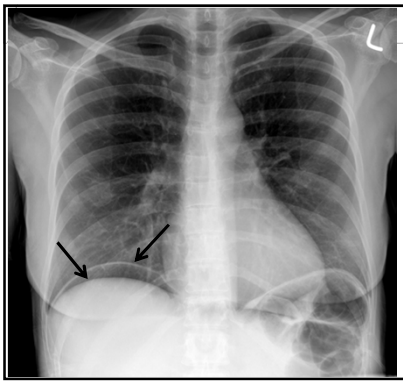
COVID

- Ground glass opacity
- Multifocal, bilateral, and peripheral
- Chest radiograph
  - Insensitive early in disease
  - Useful in follow-up of disease
- Chest CT
  - Severity of lung involvement on CT correlates with severity of disease
  - Bernheim et al: 56% early patients had normal CT; longer time after sx onset, CT findings were more frequent

Bernheim et al. Radiology 2020.



Free subdiaphragmatic air



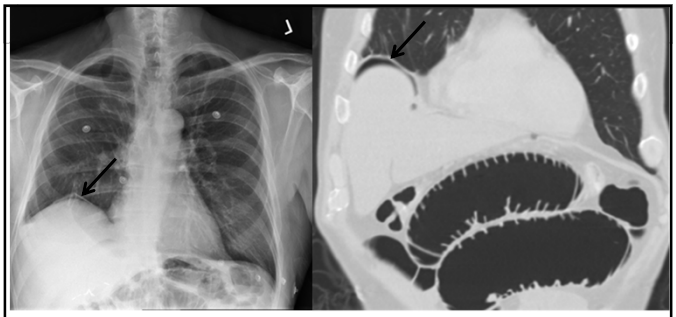
HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

Subtle free subdiaphragmatic air

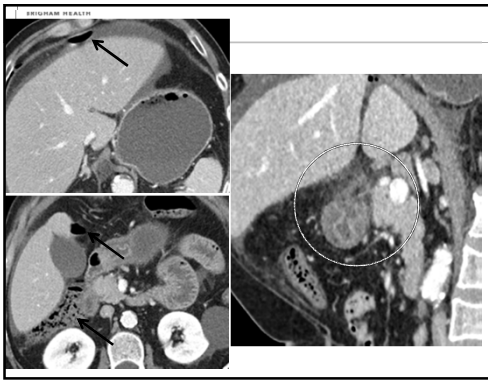
Identify liver & diaphragm

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.



HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

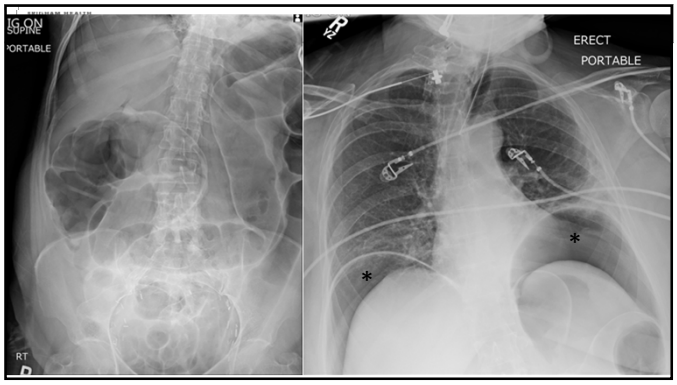
Perforated Bowel: Peptic Ulcer

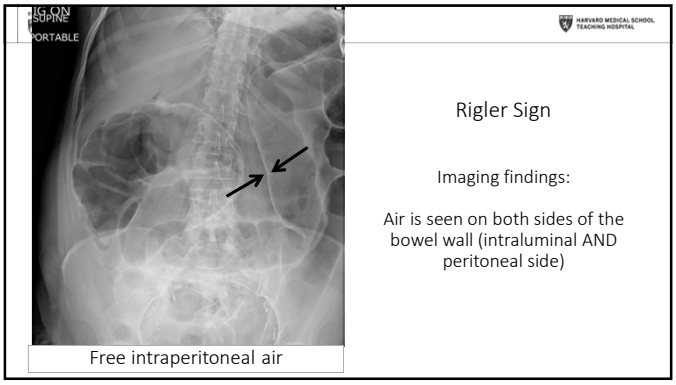
One of the most common causes of perforated bowel

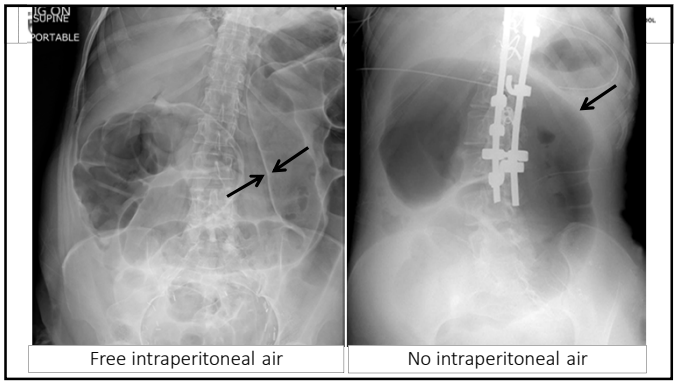
BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL
HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

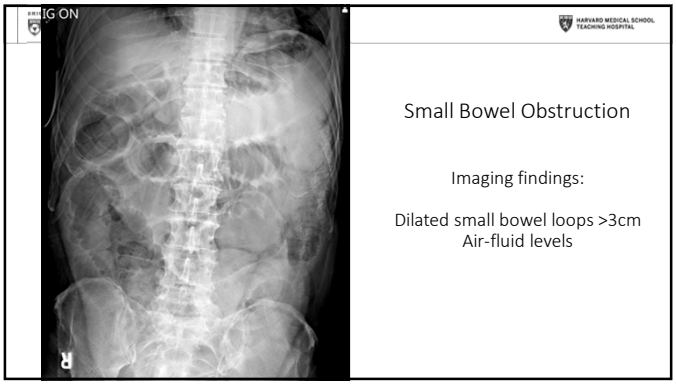
Free Intraperitoneal Air

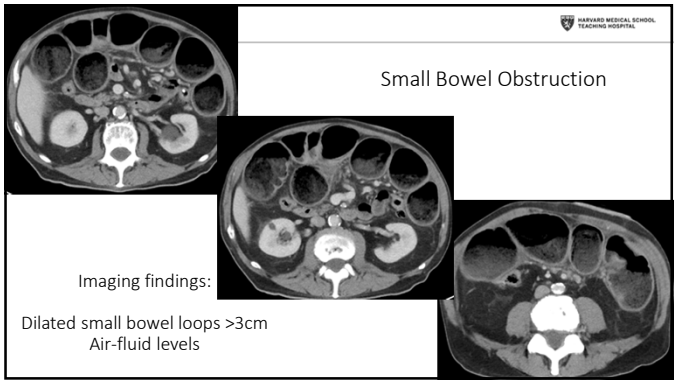
- Abdominal emergency requiring surgical or percutaneous intervention
- Contained perforations can be managed conservatively
- Most common sources:
  1. Perforated diverticulitis
  2. Perforated peptic ulcers
  3. Others: perforated carcinoma, bowel ischemia
- Iatrogenic:
  - Post endoscopy, colonoscopy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

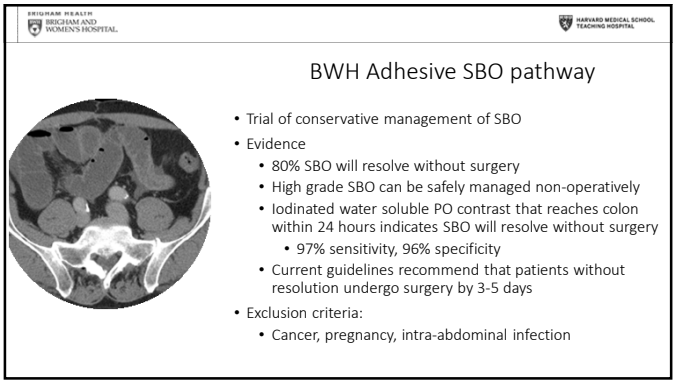

SUPINE
PORTABLE
ERECT
PORTABLE
RT


SUPINE
PORTABLE
HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL
Rigler Sign
Imaging findings:
Air is seen on both sides of the bowel wall (intraluminal AND peritoneal side)
Free intraperitoneal air

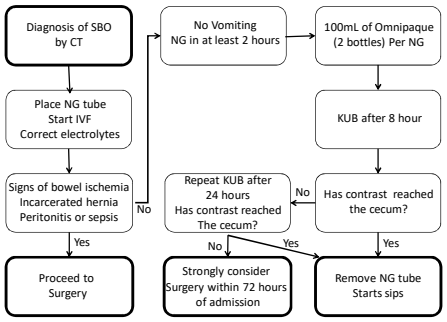

SUPINE
PORTABLE
Free intraperitoneal air
No intraperitoneal air

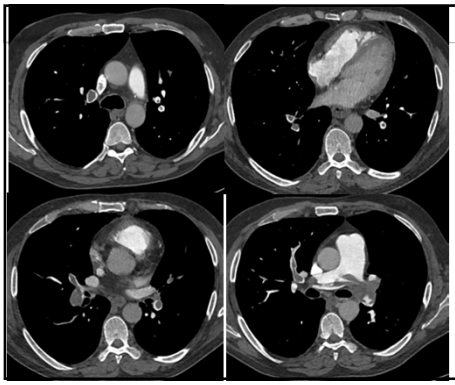

HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL
Small Bowel Obstruction
Imaging findings:
Dilated small bowel loops >3cm
Air-fluid levels


HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL
Small Bowel Obstruction
Imaging findings:
Dilated small bowel loops >3cm
Air-fluid levels


BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL
HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL
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

Adhesive Small Bowel Obstruction Pathway

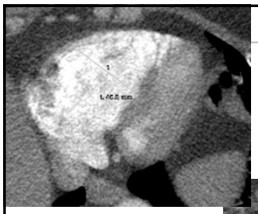


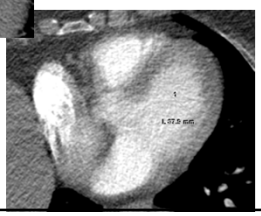


Saddle Pulmonary Embolism

Imaging findings:

Filling defects in the pulmonary arteries



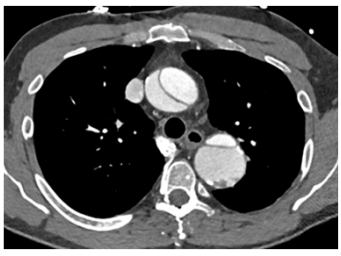


Right Heart Strain in Pulmonary Emboli

Bowing of interventricular septum

RV: LV > 1:1

67 year old male with back pain



Type A Dissection

Type B Dissection

Aortic Dissection

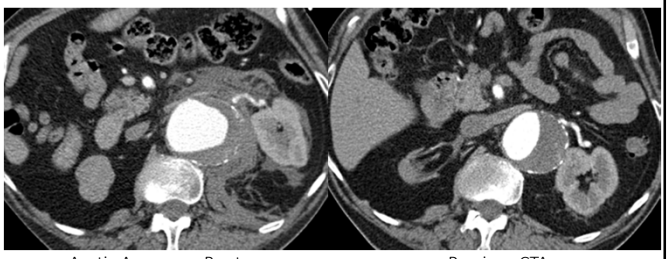
Aortic Aneurysm Rupture

Break in wall of abdominal aortic aneurysm

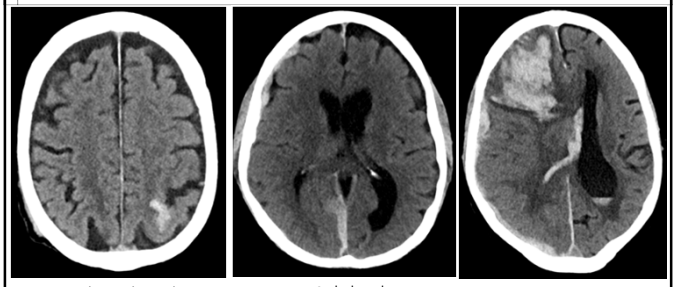
I+: AAA with active extravasation

I-: focal discontinuity of calcification

High attenuation hematoma



Aortic Aneurysm Rupture | Previous CTA

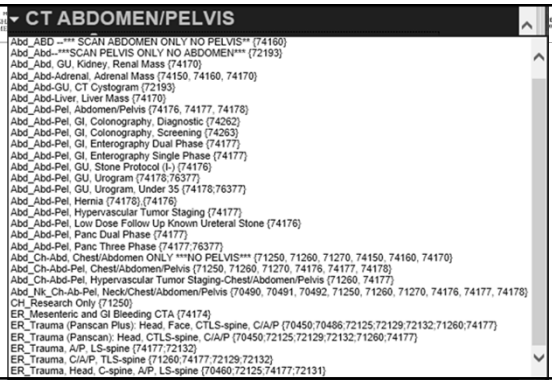


Subarachnoid hemorrhage | Subdural hemorrhage | Midline shift, herniation

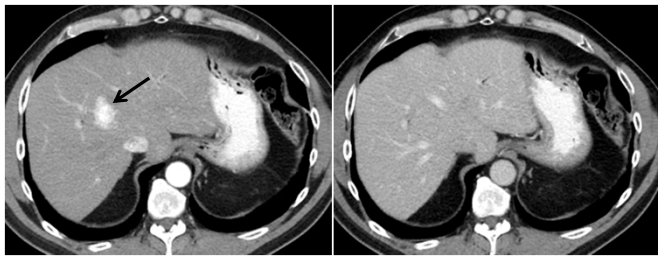
Part IV: Imaging Protocols and Considerations

Imaging Tool Box

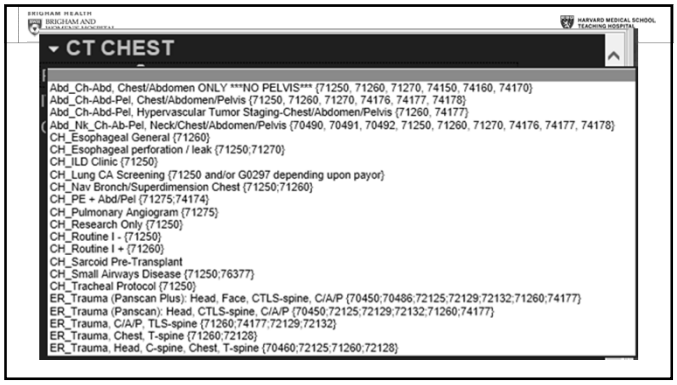
- Radiography/fluoroscopy
- Ultrasound (US)
- Computed tomography (CT)
- Magnetic resonance imaging (MR)
- Nuclear medicine (PET/CT, GI bleeding scan, HIDA, bone scan, etc)

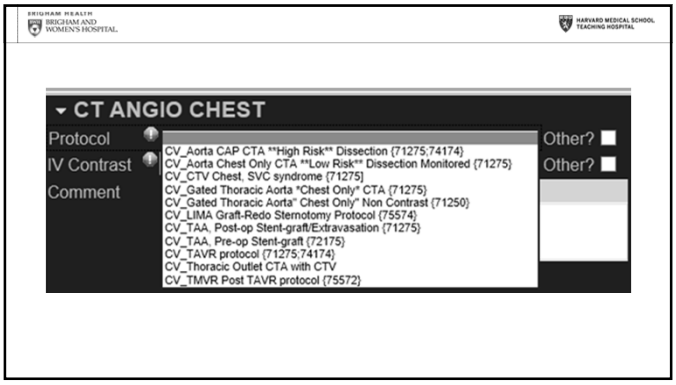


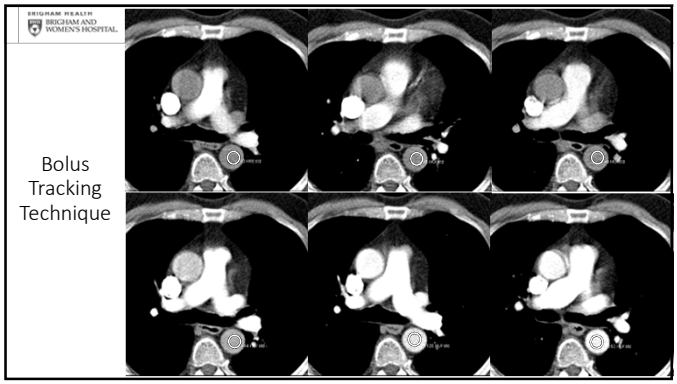
Pancreatic Neuroendocrine Tumor



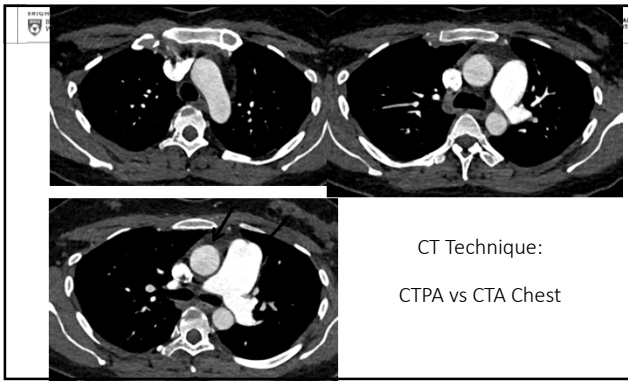
Arterial Phase CT AP | Portal Venous Phase CT AP







Bolus Tracking Technique



CT Technique:

CTPA vs CTA Chest

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

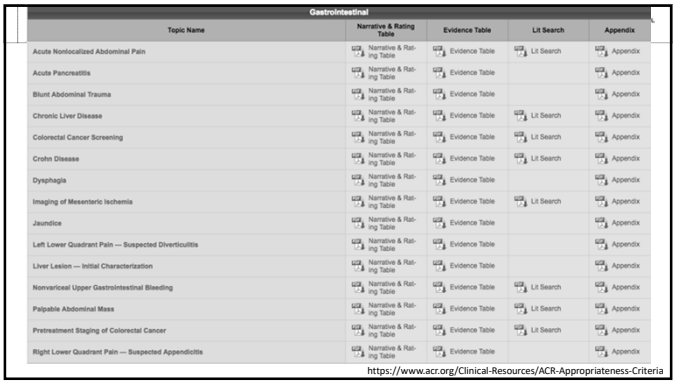
IR/Angio

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

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

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	☢☢

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

BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

Part V:
Oral and Intravenous Contrast for CT Examinations

BRIGHAM HEALTH
BRIGHAM AND WOMEN'S HOSPITAL

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

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

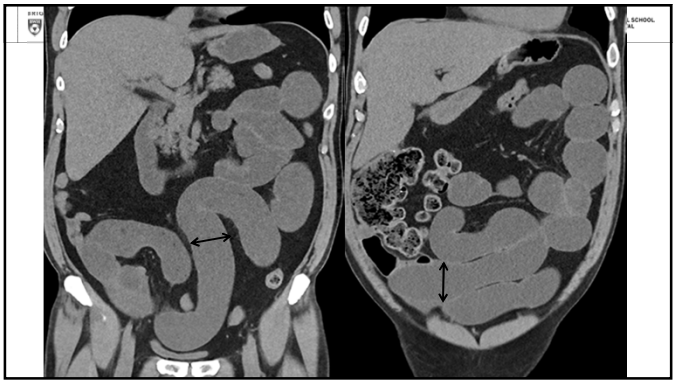
PURPOSE: To evaluate the rate of delayed or missed diagnoses and need for additional computed tomography (CT) imaging in emergency department patients with abdominal pain who are imaged without oral contrast.

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.

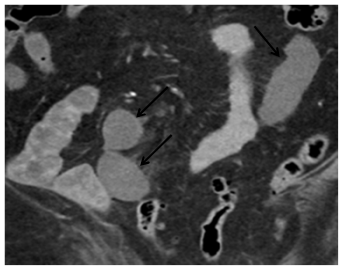
RESULTS: Of the 1992 patients included in this study, 4 patients (0.2%) underwent repeat CT studies directly related to the absence of oral contrast on the original examination. Of the 1992 CT scans, 1193(59.8%) were interpreted as negative, none of which required surgery or direct intervention. In patients 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



Ischemic Small Bowel



Use of PO Contrast

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

Utility of IV Contrast

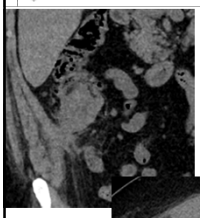
3/4/2017 6:00 AM

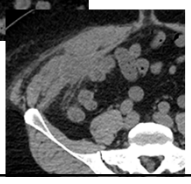
No stones or hydronephrosis

3/4/2017 11:35 PM

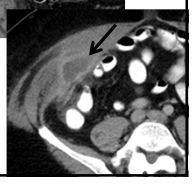
Renal infarct

S/P Appendectomy





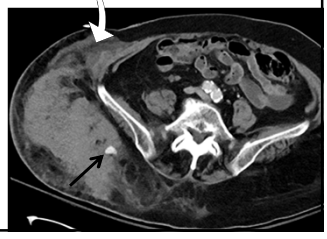
+IV Contrast

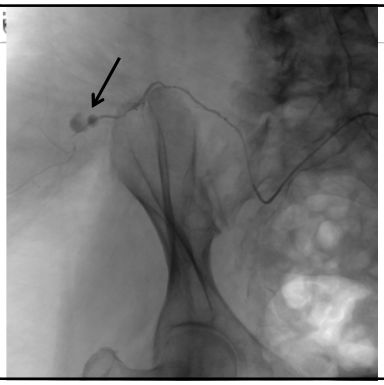


Anastomotic & abdominal wall abscesses

Soft Tissue Hematoma

+IV Contrast

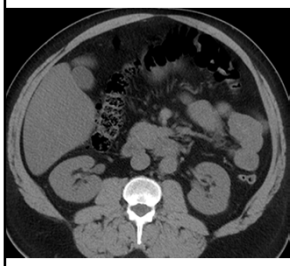




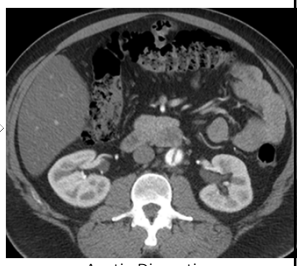
Pseudoaneurysm in soft tissue hematoma

Requiring coil embolization

Abdominal Pain

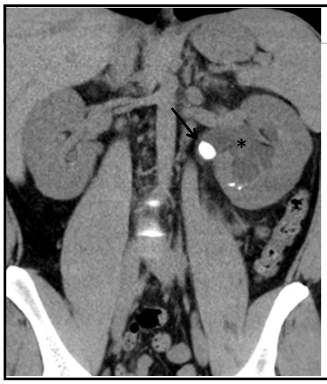


+IV Contrast



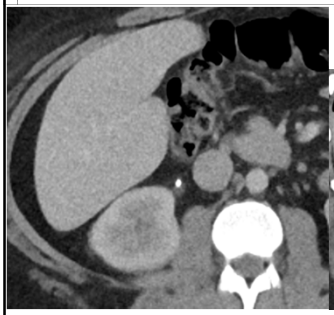
Aortic Dissection

SMA thrombus with infarcted loops of small bowel



Nephrolithiasis

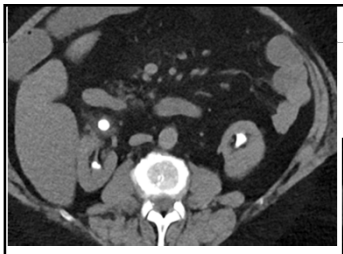
Noncontrast CT



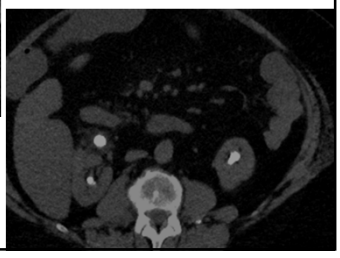
Nephroureterolithiasis

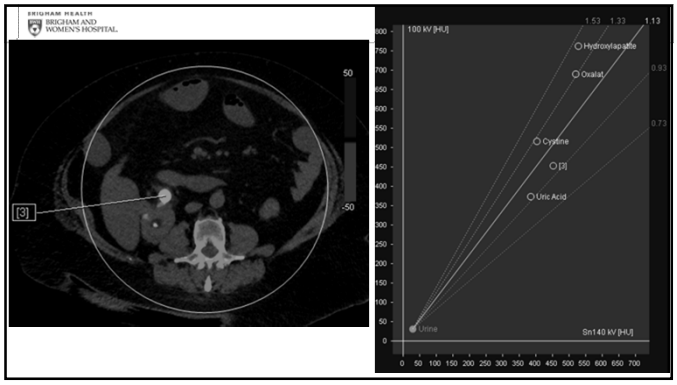
+IV CT (Routine PV phase)

R proximal ureteral stone w hydronephrosis, delayed nephrogram



Uric Acid Stones analysis by Dual Energy CT





Part VI: Renal Failure and Contrast Allergies

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

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

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

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

- Prednisone-based:
  - 50 mg prednisone by mouth 13, 7, and 1 hour before contrast administration + 50 mg diphenhydramine IV, IM, or PO 1 hour before contrast administration

OR

- Methylprednisolone-based:
  - 32 mg methylprednisolone by mouth 12 hours and 2 hours before contrast administration. 50 mg diphenhydramine may be added as an option.

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

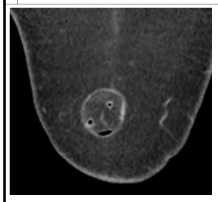
Allergic Reactions

- 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

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

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