What your Radiologist wishes you knew

Ordering advanced imaging in the Thorax

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Disclosures

- None

Objectives

- Describe radiation risk in medical imaging.
- Explain how patient factors such as pregnancy, renal disease and allergies affect imaging choices
- List common imaging protocols used in the chest.

- Know what might be possible and when to call your radiologist!

Outline

- Cases
- Radiation Risk
- Pregnancy & Breastfeeding
- Contrast Allergies
- Renal Disease
- Protocols

Cases

Case 1

- 25 year old male with knee osteosarcoma.
  - What are your options for screening for lung metastases?
  - How much risk does radiation pose for this patient?
  - Do you need contrast?

Case 2

- 35 year old pregnant female with newly diagnosed breast cancer is short of breath.
  - What are your imaging choices for evaluating PE?
  - What is the radiation risk to the child?
  - Does pregnancy limit your contrast options?

- After delivering, the patient will have a PET/CT for staging.
  - Does the patient need to isolate from the newborn?
  - Can the patient breast feed?

Case 3

- 68 year old Female with small cell carcinoma of the lung and listed contrast allergy.
  - Can this patient ever get contrast?
  - How effective is pre-treatment for contrast allergies?

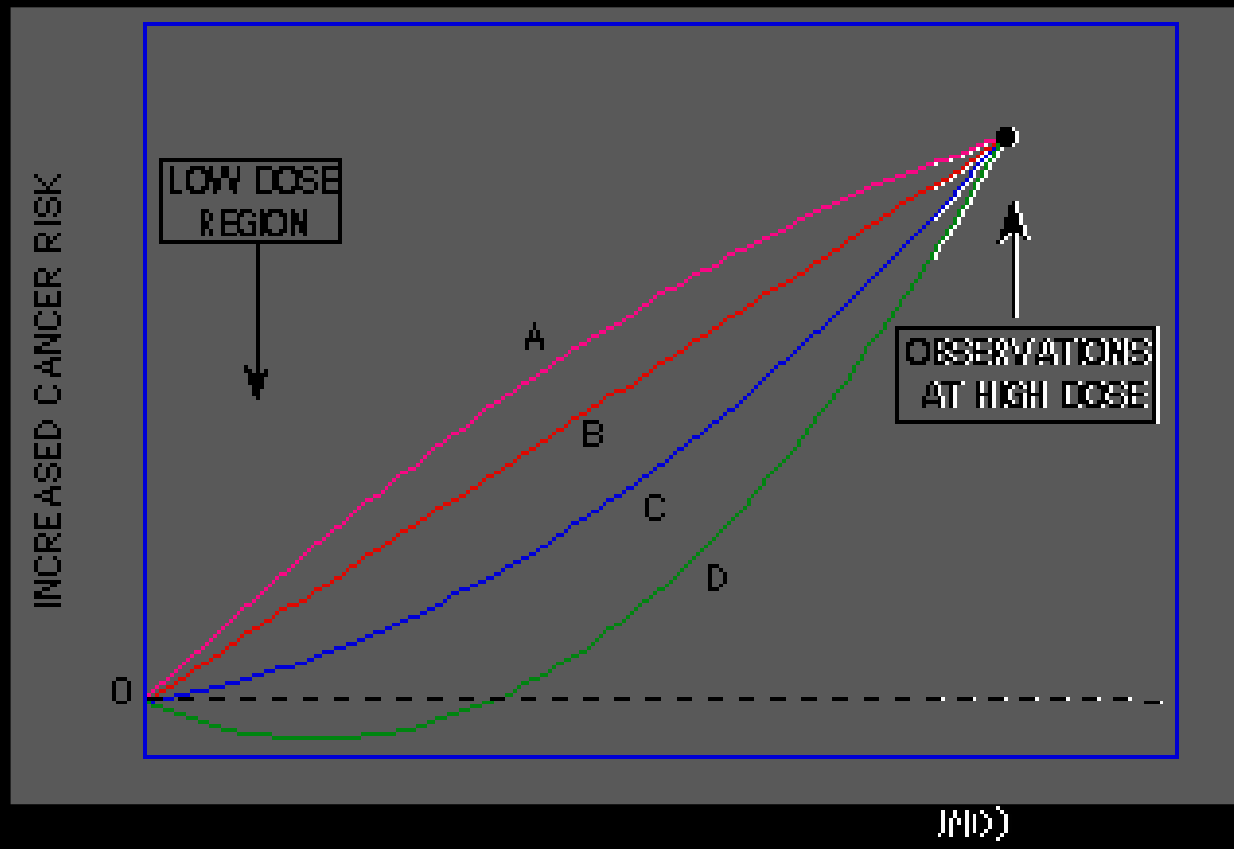
Case 4

- 75 year old man with lung adenocarcinoma, stage 4 CKD, and elevated LFTs. You want to evaluate for metastases.
  - Does this patient need contrast?
  - What are the risks of CT and MRI contrast?

Radiation Risk

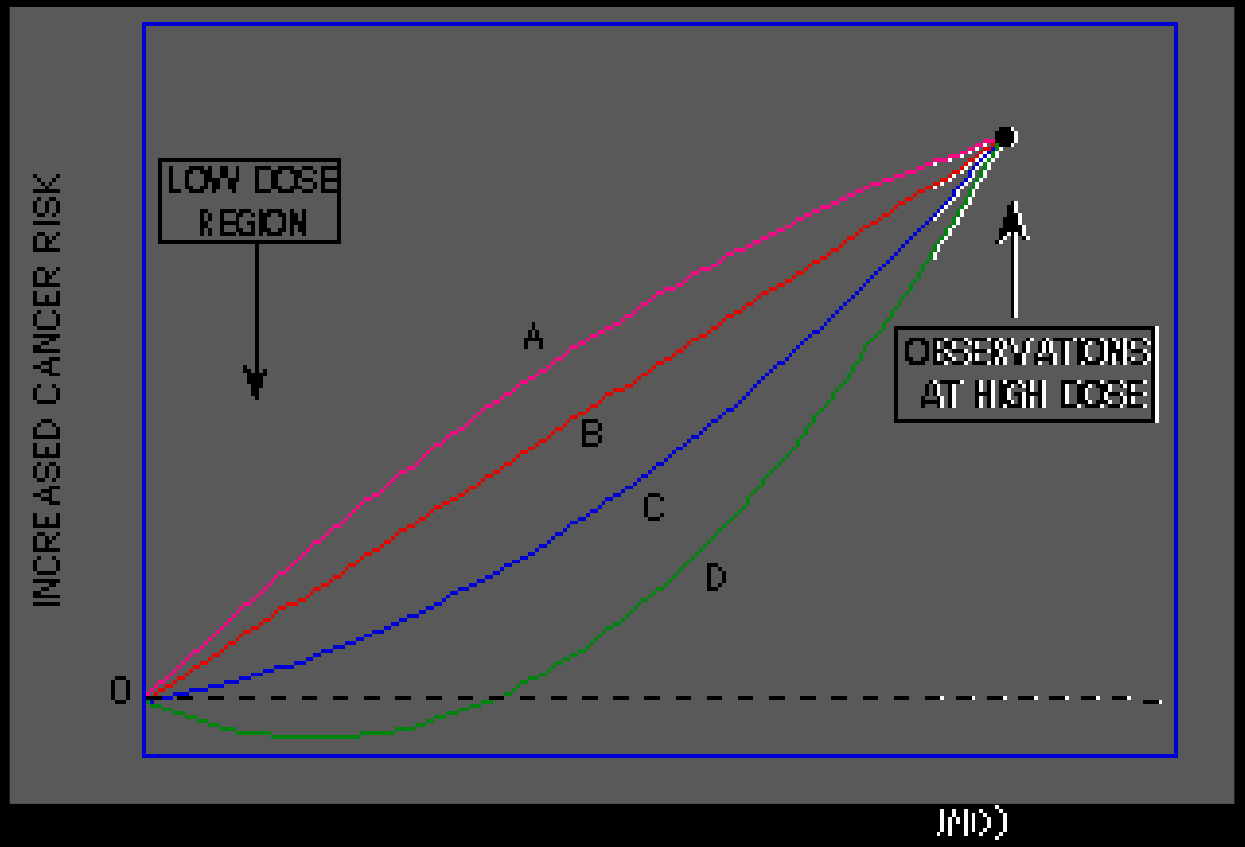
Radiation Background

- Radiation Causes Cancer
- Background Cancer risk 42/100
- 100 mSv radiation risk is 1/100
- Cannot measure risk below 100 mSv
- Background radiation
  - 2-4 mSv in most of USA
  - 11.8 in Denver (elevation, uranium)
  - Up to 260 mSv in Ramsar Iran (uranium/radon, hot springs)



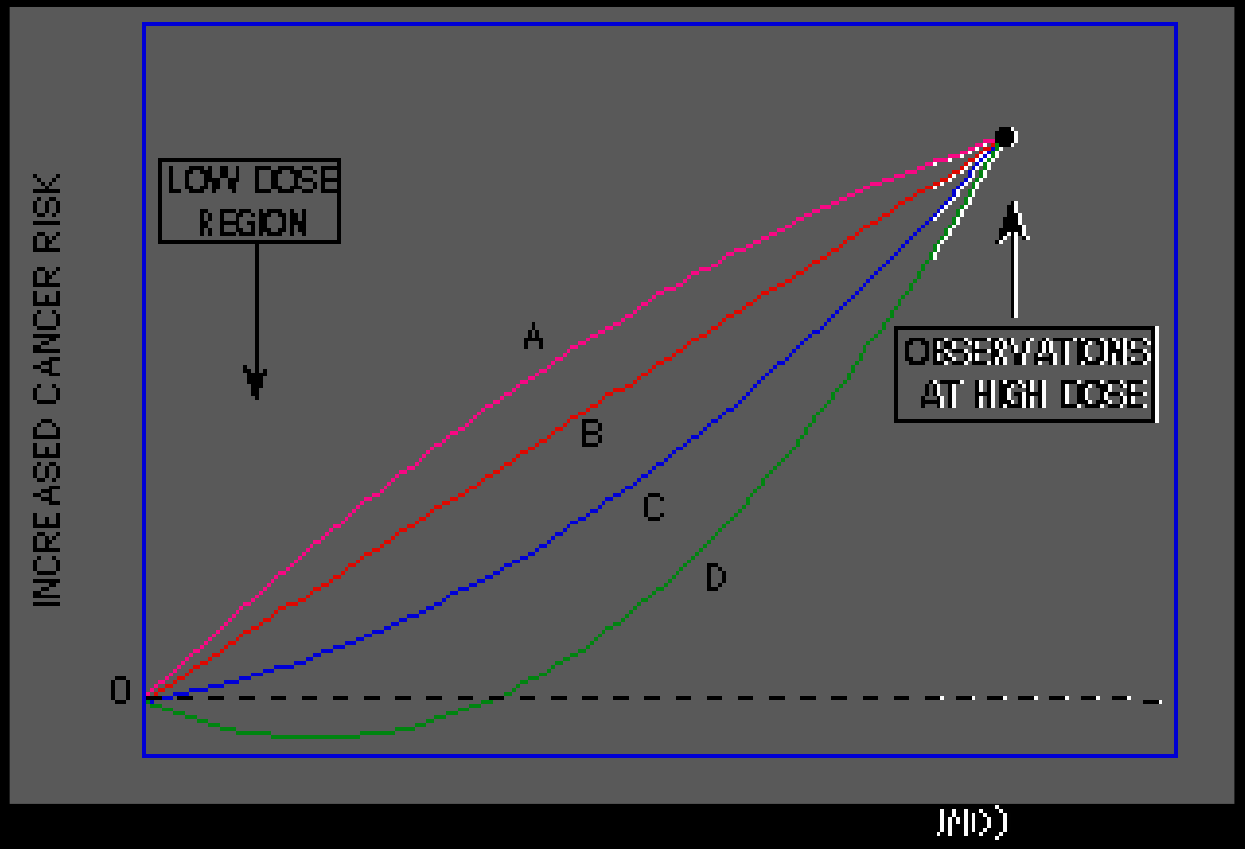
Approximate Radiation Doses

- 2 view CXR = < 0.1 mSv
- Mammogram = 0.4 – 1.5 mSv
- Low dose Chest CT = 0.8 mSv
- Diagnostic Chest CT = 3 mSv
- Abdomen/Pelvis CT = 7 mSv
- PET/CT = 25 mSv



Radiation Risk

- Best Guesses:
- 1:100,000 risk
  - 2 view CXR = < 0.1 mSv
- 1:10,000 risk
  - Mammogram = 0.4 – 1.5 mSv
  - Low dose Chest CT = 0.8 mSv
- 1:1000 risk
  - Diagnostic Chest CT = 3 mSv
  - Abdomen/Pelvis CT = 7 mSv
- 1:500 risk
  - PET/CT = 25 mSv



Pregnancy and Breastfeeding

https://www.publicdomainpictures.net/pictures/50000/velka/pregnancy.jpg

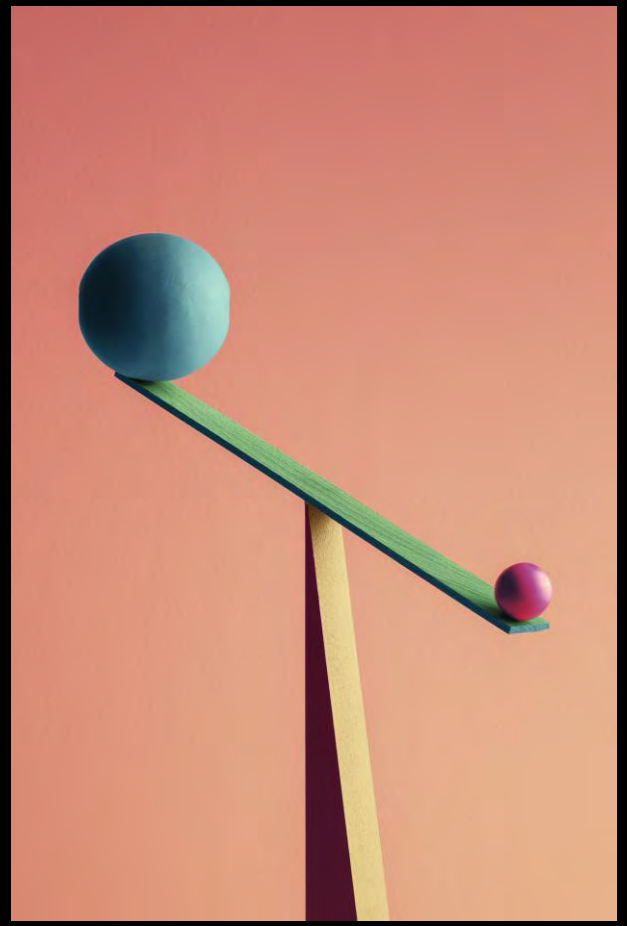
Pregnancy and Radiation - Risk

- Radiation risk to fetus is even harder to measure for imaging doses
- ACR – Child's cancer risk approximated at 4/1000 at 10 mSv
- Other risks at 100 mSv
  - 3rd – 4th weeks – possible SAB
  - 5th – 10th weeks – possible malformations
  - 11th – 17th weeks – risk of diminished IQ
  - 18th – term – no discernable deficits
- Below 100 mSv other risks are not detectable.

ACR–SPR PRACTICE PARAMETER FOR IMAGING PREGNANT OR POTENTIALLY PREGNANT PATIENTS WITH IONIZING RADIATION, 2023

Pregnancy and Radiation - Screening

- Must weigh risks and benefits of exam
- Policies vary by hospital
- ACR - Examinations that may require verification of pregnancy status:
  - Interventional fluoroscopic procedures of the abdomen or pelvis
  - Hysterosalpingography
  - Standard-dose CT protocols of the abdomen or pelvis
  - Diagnostic nuclear medicine studies



ACR–SPR PRACTICE PARAMETER FOR IMAGING PREGNANT OR POTENTIALLY PREGNANT PATIENTS WITH IONIZING RADIATION, 2023

Pregnancy and Radiation – Counseling

- ACR:

"Your child will have nearly the same chances of living a healthy life as any other child under similar medical circumstances. The risk your child might develop cancer from this imaging procedure is very small. The risk of a birth defect from this imaging procedure is negligible or nonexistent."

Pregnancy and Contrast

- Iodinated Contrast (CT)
  - Does cross placenta
  - No Known adverse effects
  - Usually needed to make diagnosis
  - FDA Class B – No risk in animal studies
- Gadolinium Contrast (MRI)
  - Crosses Placenta, may accumulate in fluid
  - Theoretically Gd could dissociate – NSF
  - Usually can make diagnosis without contrast

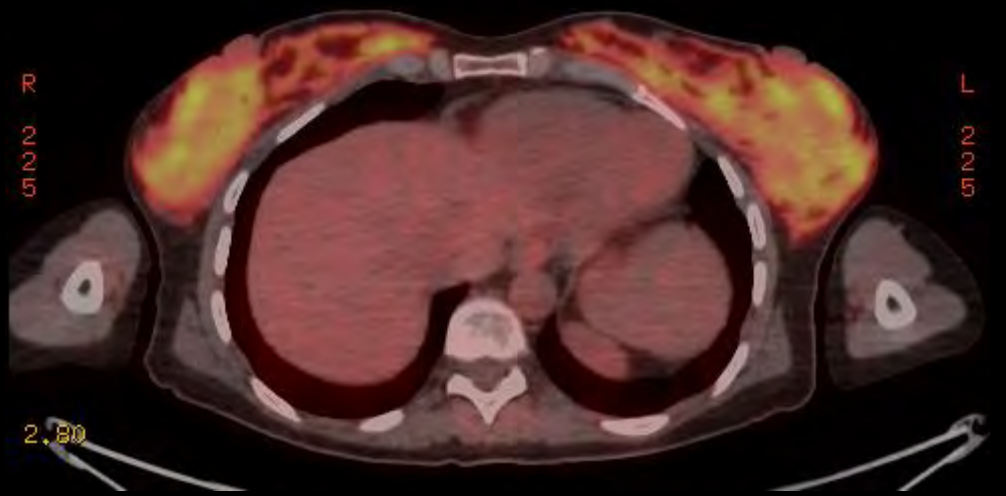
Breastfeeding - Contrast

- Iodinated Contrast (CT)
  - No need to stop
  - <1% excreted into breast milk
  - <1% absorbed by infant
- Gadolinium Contrast (MRI)
  - No need to stop
  - Less than 0.04% excreted into breast milk

Both agents cleared in 24hrs if mother chooses to pump and dump.

Breastfeeding – Nuclear Medicine

- FDG PET
  - Agent is not excreted in milk
  - Accumulates in breast tissue – limit contact
  - Pump and Bottle x 12 hours (ABM)
- Tc-99m (Bone Scan, Heart studies, HIDA)
  - May not be excreted
  - Easiest to pump, store 60 hours
- I-131 (Thyroid therapy)
  - Must stop breast feeding 4 weeks prior

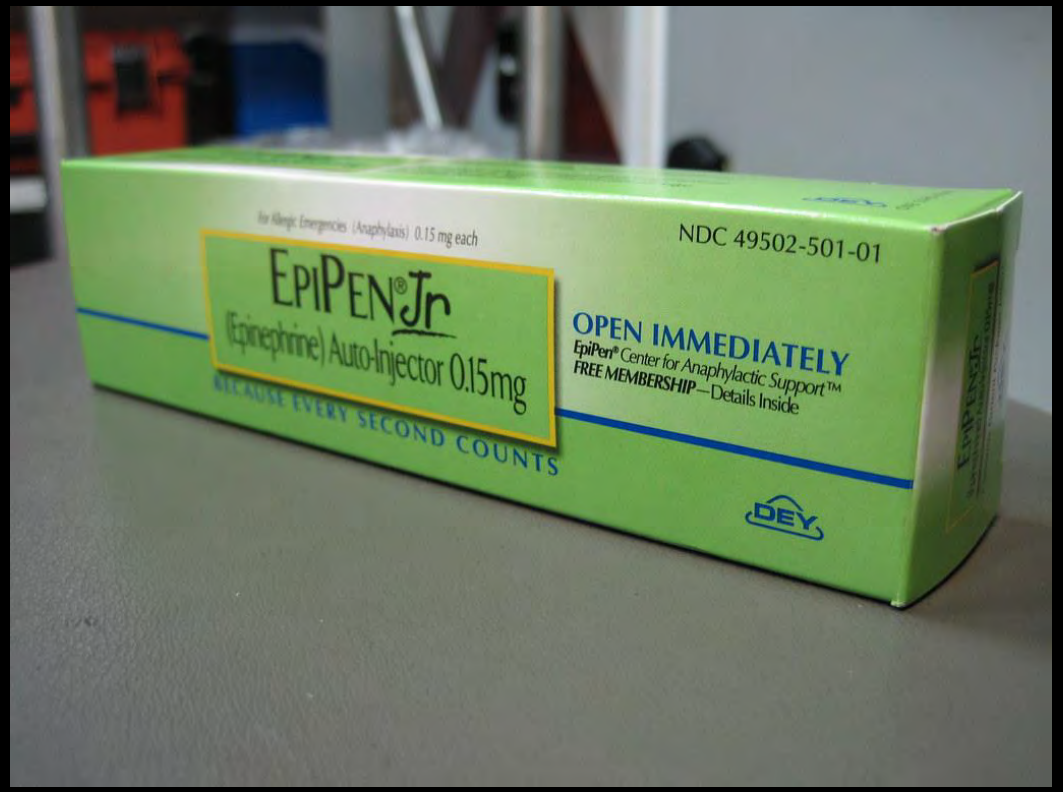


ABM Clinical Protocol #31: Radiology and Nuclear Medicine Studies in Lactating Women, 2019

Contrast Allergies

Contrast Allergy Background

- “Allergic Like” no antibody – antigen
- May relate to histamine release
- Different from physiologic/vasovagal reactions
- <1% rate with modern CT contrast
- Risk Factors
  - Prior Reaction (10-35%)
  - Atopic individuals
  - Asthma
  - Severe Cardiac Disease (physiologic)



Types of Contrast Reactions

Mild

Signs and symptoms are self-limited without evidence of progression. Mild reactions include:

Allergic-like	Physiologic
Limited urticaria / pruritis	Limited nausea / vomiting limited
Cutaneous Edema	Transient flushing / warmth / chills
Limited "itchy"/"scratchy" throat	Headache / dizziness / anxiety / altered taste
Nasal congestion	Mild hypertension
Sneezing / conjunctivitis / rhinorrhea	Vasovagal reaction that resolves spontaneously

Moderate

Signs and symptoms are more pronounced and commonly require medical management. Some of these reactions have the potential to become severe if not treated. Moderate reactions include:

Allergic-like	Physiologic
Diffuse urticaria / pruritis	Protracted nausea / vomiting
Diffuse erythema, stable vital signs	Hypertensive urgency
Facial edema without dyspnea	Isolated chest pain
Throat tightness or hoarseness without dyspnea	Vasovagal reaction that requires and is responsive to treatment
Wheezing / bronchospasm, mild or no hypoxia	

Severe

Allergic-like	Physiologic
Diffuse edema, or facial edema with dyspnea	Vasovagal reaction resistant to treatment
Diffuse erythema with hypotension	Arrhythmia
Laryngeal edema with stridor and/or hypoxia	Convulsions, seizures
Wheezing / bronchospasm, significant hypoxia	Hypertensive emergency
Anaphylactic shock (hypotension + tachycardia)	

ACR Manual on Contrast Media, 2023

Pretreatment

- Treatment strategies use steroids +/- diphenhydramine

- Benefits:
  - 2% breakthrough reaction rate
  - Most similar severity
- Risks
  - Delay exam
  - Hyperglycemia

Pretreatment Regimens

- 13 hour outpatient
  - 50mg Prednisone at 13, 7, and 1 hours prior to scan
  - 50 mg Diphenhydramine 1 hour prior to scan

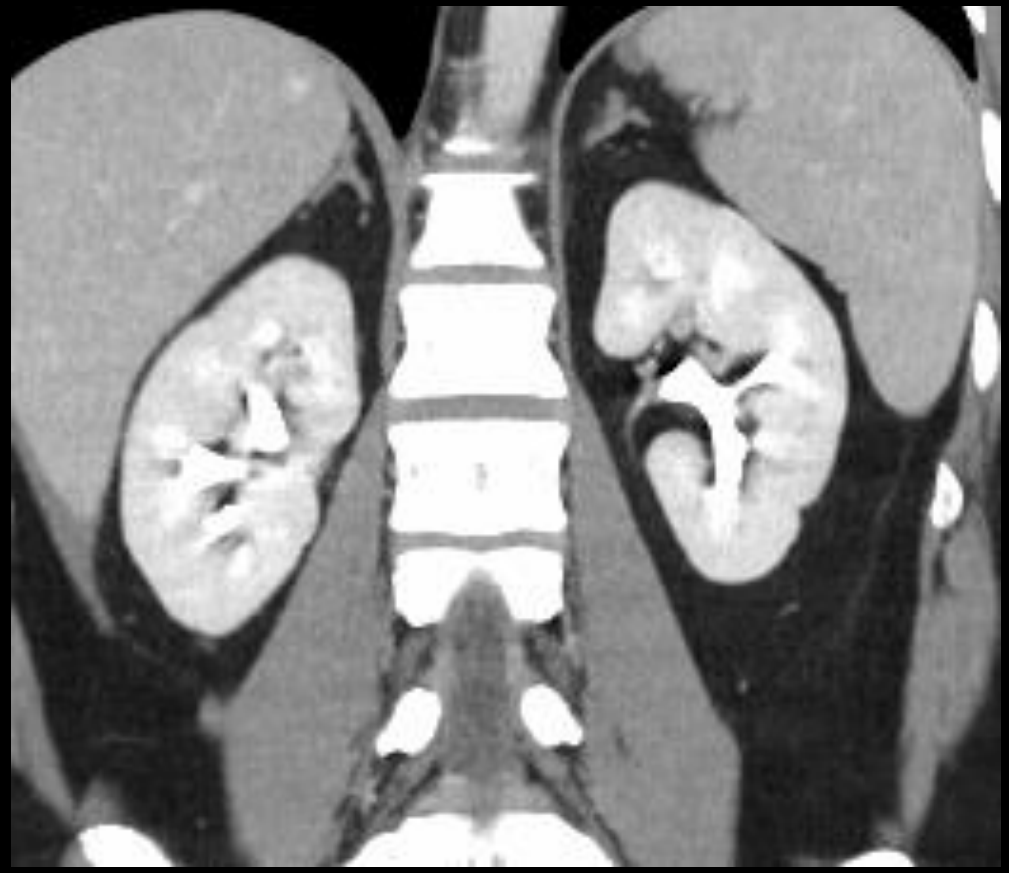
- 5 hour inpatient
  - 40 mg methylprednisolone IV, every 4 hours until exam
  - 50 mg Diphenhydramine IV 1 hour prior to exam
  - Minimum 4-5 hours duration

- No Evidence for regimens shorter than 4-5 hours.

Renal disease

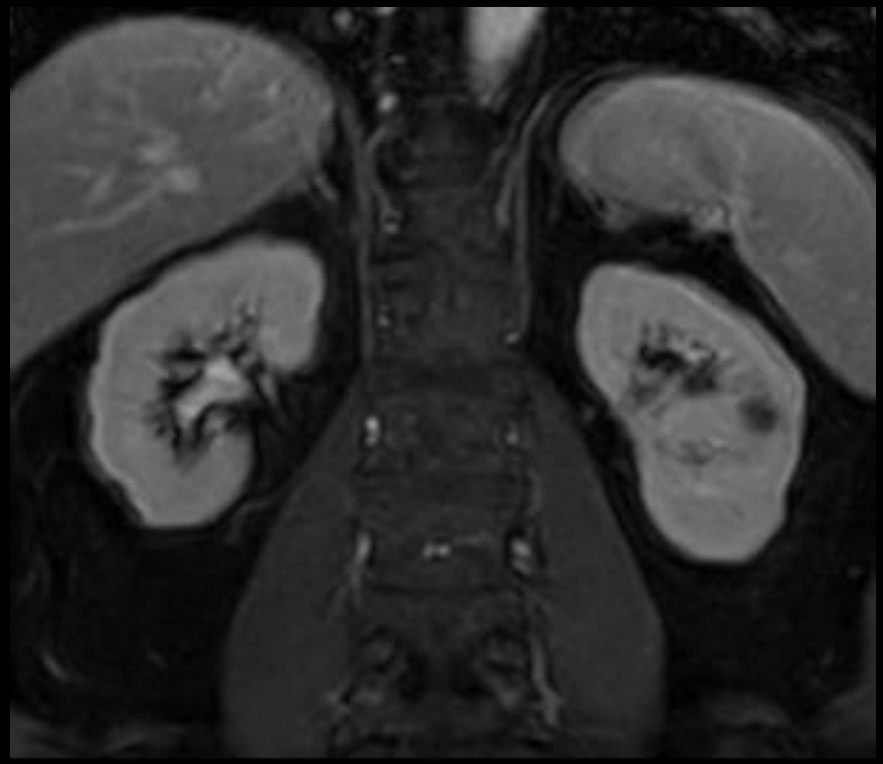
CKD and Iodinated (CT) Contrast

- Contrast Induced Acute Kidney Injury
- Difficult to show causality
- Per ACR – Real but rare
- Risks
  - Intraarterial Admin (cardiac)
  - Acute Kidney Injury
  - Chronic CKD with GFR < 30
- OK to give in Anuric Dialysis patients
- Failure to diagnose has risks as well



CKD and Gadolinium (MRI) Contrast

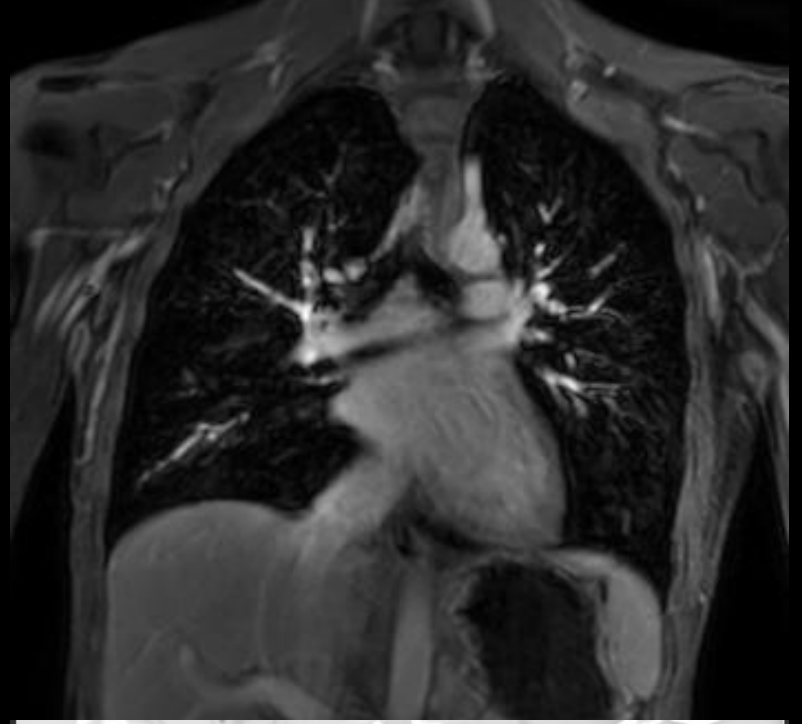
- MRI Contrast initially thought to be safe in CKD
- In 2000's patients with ESRD developed Nephrogenic Systemic Sclerosis.
  - Associated with MRI contrast
- Risk Factors
  - CKD with GFR < 30
  - Multiple Administrations
  - Contrast agent type
- Newest agents - very low or non-existent risk
  - OK to administer when indicated
- Perform before dialysis if possible in ESRD



Protocols

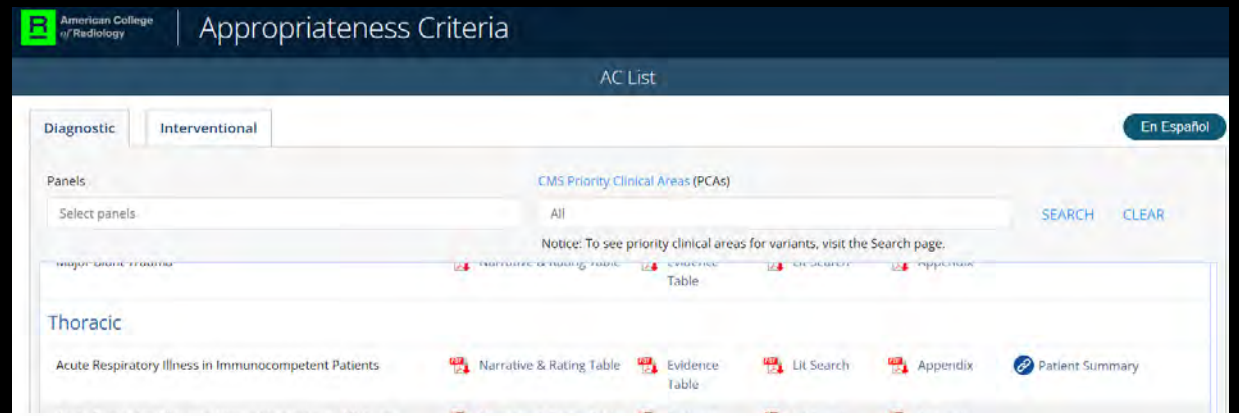
When to order CT vs MRI

- In the chest, CT is almost always best
  - Particularly good for lung evaluation
- MRI is helpful for:
  - Soft tissue/muscle
  - Spine & cord
  - Thymic cysts
  - Can consider in young patients



CT contrast vs non-contrast

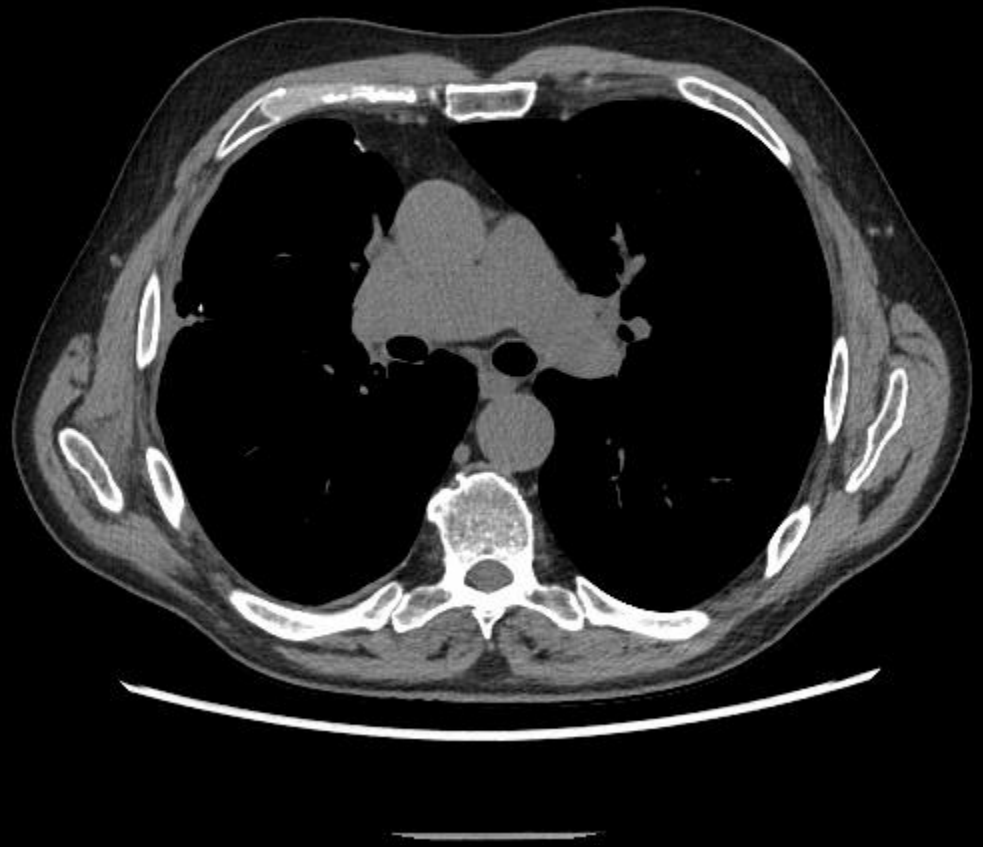
- No need for contrast to see pulmonary nodules
  - Screening
  - Nodule Follow-up
- Contrast
  - Helpful for soft tissues
  - Mediastinum/Hilum
  - Vasculature
- Contrast almost always helpful in abdomen/pelvis



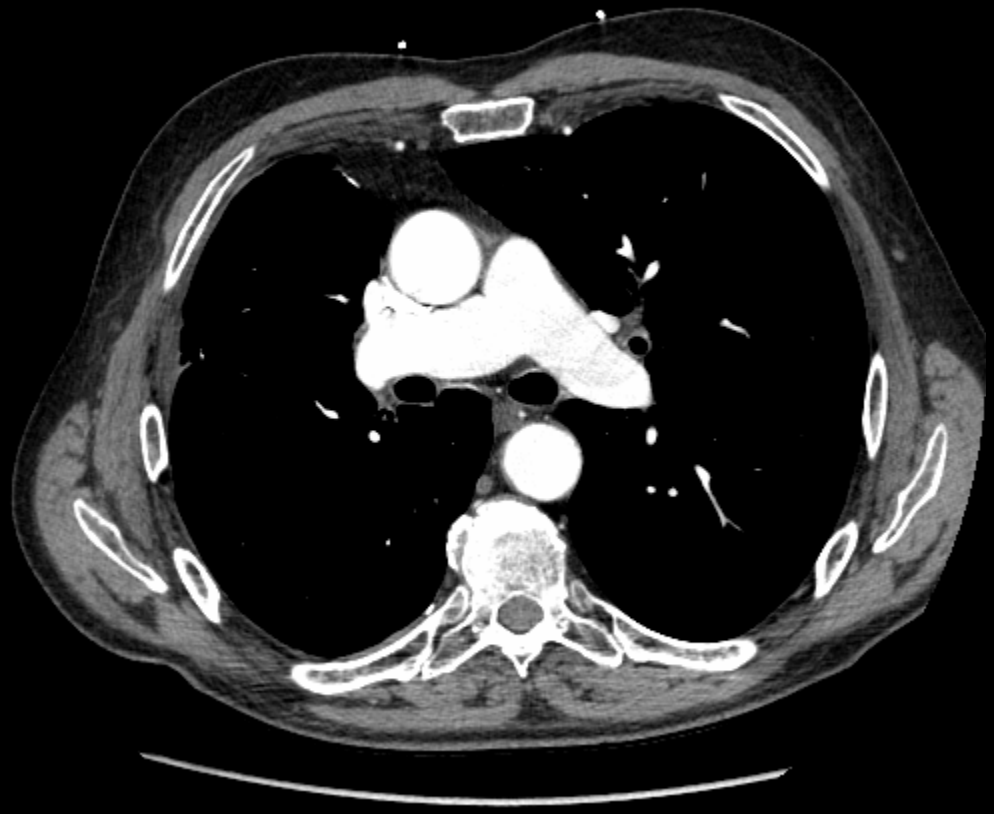
Variant 1: **Suspected diffuse lung disease. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	☢
CT chest without IV contrast	Usually Appropriate	☢☢☢
CT chest with IV contrast	May Be Appropriate	☢☢☢
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

Example Case

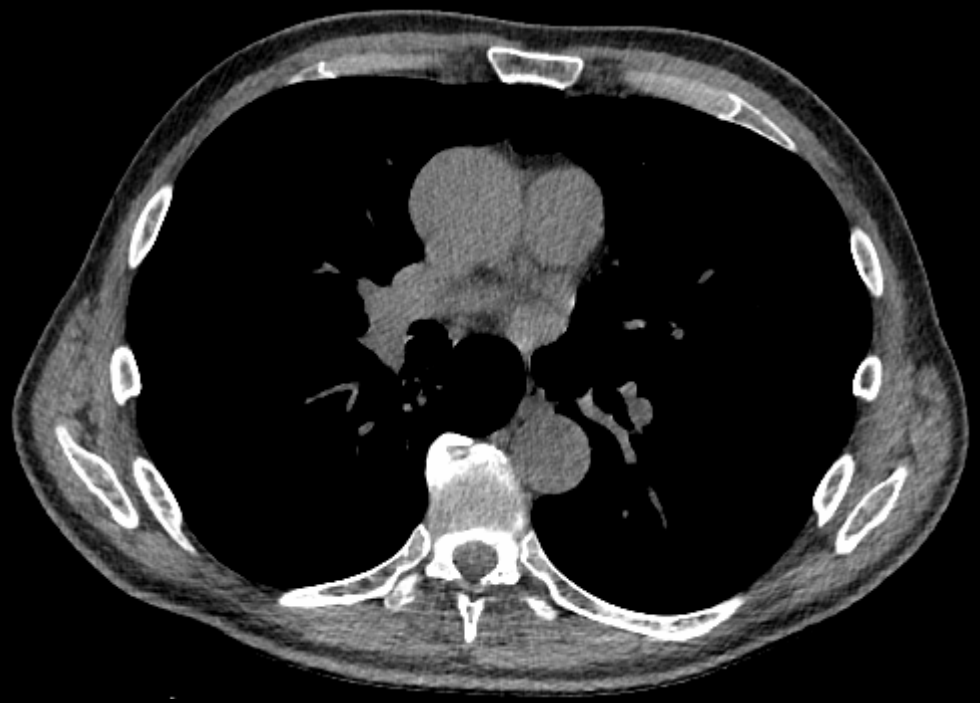


1 month later with contrast

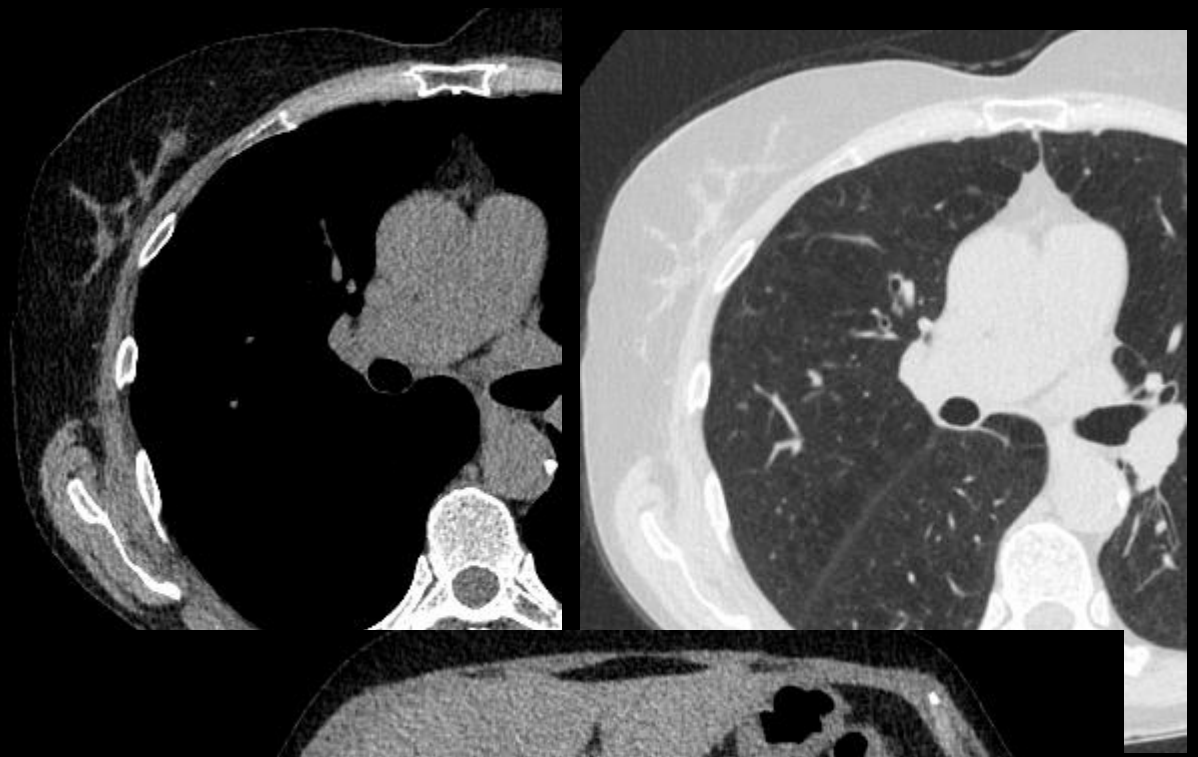


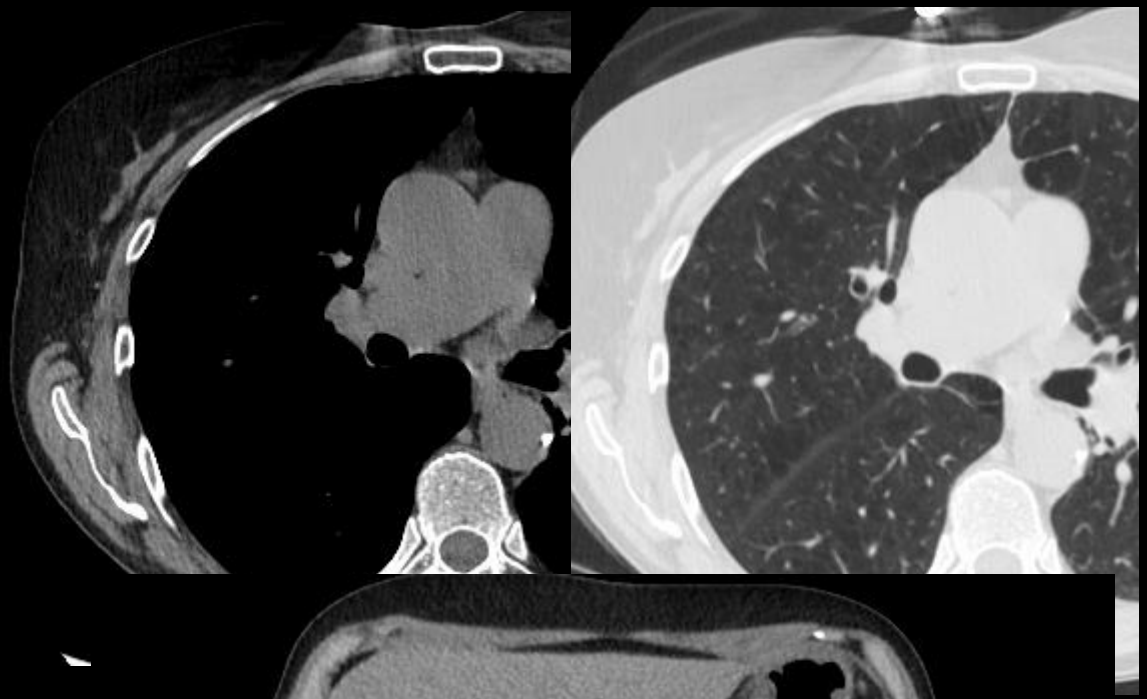
Low dose vs Regular

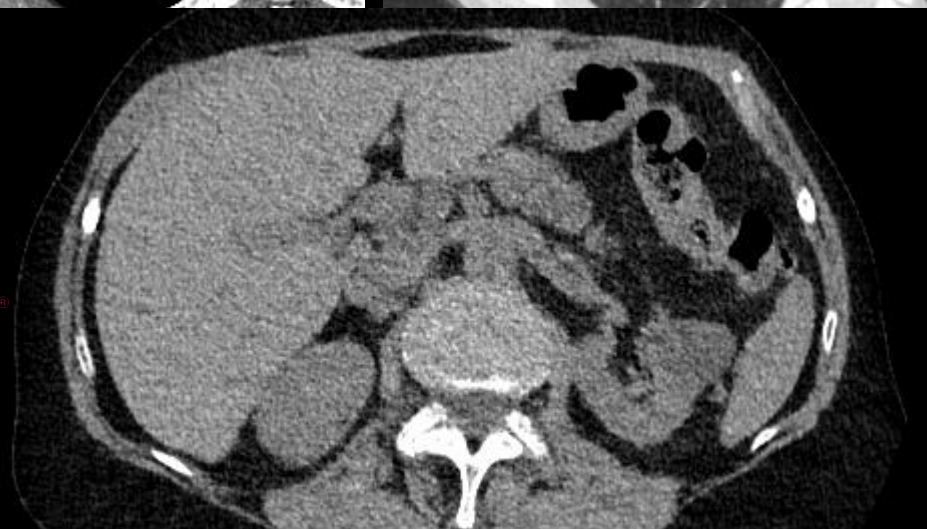
- Low dose excellent for pulmonary nodules
- Limited evaluation of soft tissues
- Lung cancer screening
- Surveillance in young patients



Low dose vs regular example

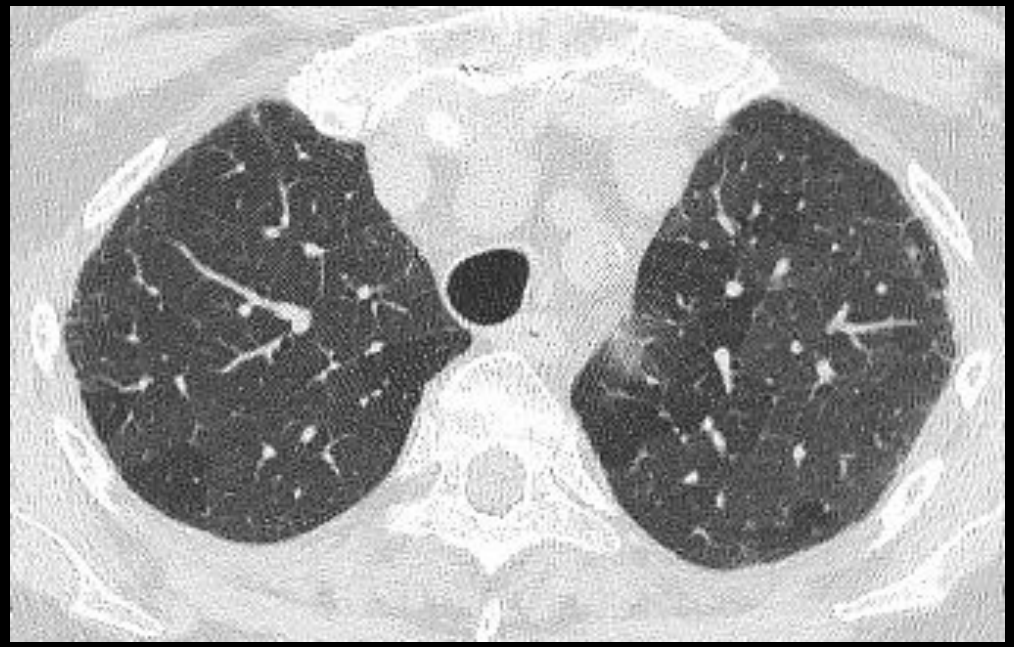


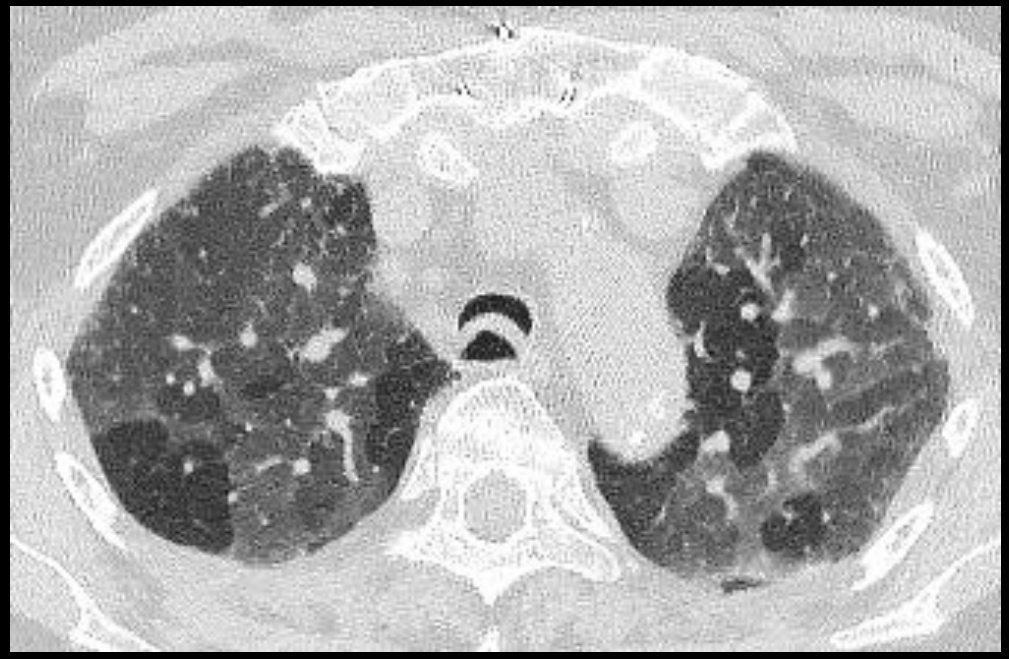




High Resolution Chest CT

- Misnomer
- Adds expiratory views
- Maybe Prone
- Helpful for air trapping, fibrosis
- Evaluation for ILD





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  - How much risk does radiation pose for this patient?
  - Do you need contrast?

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Questions?