The Top 10 Things a Primary Care Physician Needs to Know about Radiology

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DISCLOSURES

I HAVE NO DISCLOSURES

OBJECTIVES

1. Identify
   - The part of the CLINICAL HISTORY the radiologist needs to know
   - what not to say in the clinical history.
2. Decide when CONTRAST is needed for CT scans.
3. Learn the basics of WHEN TO ORDER X-RAY/CT/US/MRI
4. Learn where to get help to manage common INCIDENTALOMAS in radiology reports.

Outline

1. CLINICAL Indication
2. Principles to adhere when ordering studies.
3. Contrast or no Contrast, that is the Question.
4. Order the Correct Study
5. Follow-up Guidelines
6. Abbreviations
7. The humble chest X-ray
8. Lung Cancer Screening & Incidental Lung Nodules
9. Pearls
10. MRI

1. CLINICAL INDICATION

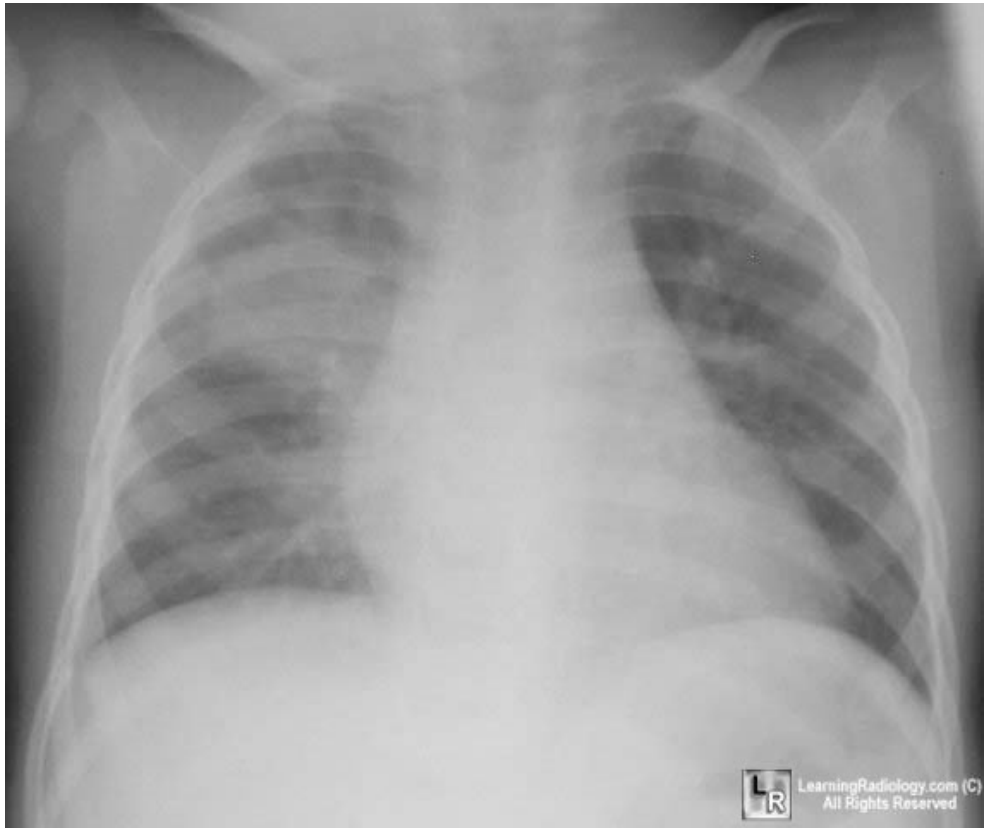
#1 CLINICAL INDICATION 1/2

- **Provide us history on the clinical section – crap in equals crap out**
  - This will minimize the dreaded “clinical correlation recommended”
  - Please don’t say –
    - F/U abnormal CT
    - Recommended by radiologist/GI/whoever
    - Rule out anything
      - When you start with RULE OUT REMEMBER – THAT IS RULE #1 – DON’T START WITH RULE OUT
    - Don’t copy and paste impression on prior study
    - Don’t give me ICD Code
    - Patient on Blank drug for re-staging.

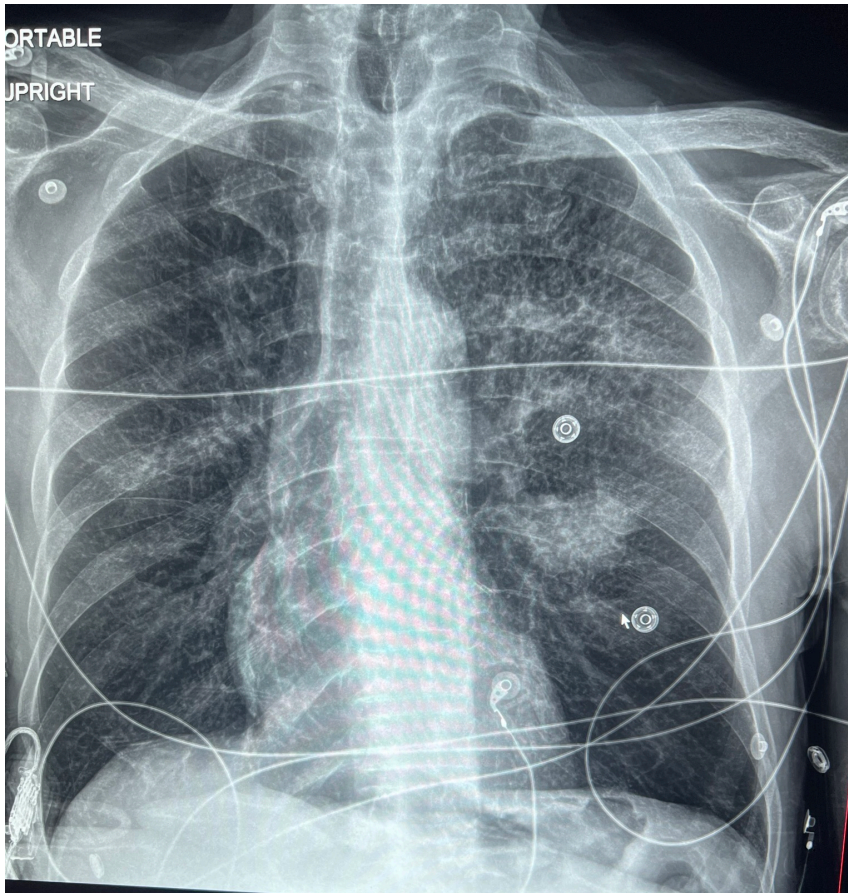
#2 CLINICAL INDICATION 2/2

- Give history of prior malignancy or relevant chronic disease
- Location of ulcer when you are concerned about osteomyelitis
- Provide a summary of why you are ordering the exam, sign and symptoms and what you are concerned about:
  - Just like when you place a consultation for a specialist
  - Radiologist should not have to look at prior study to protocol the exam

Round pneumonia VS cancer



3 year old with fever
and elevated white WBC

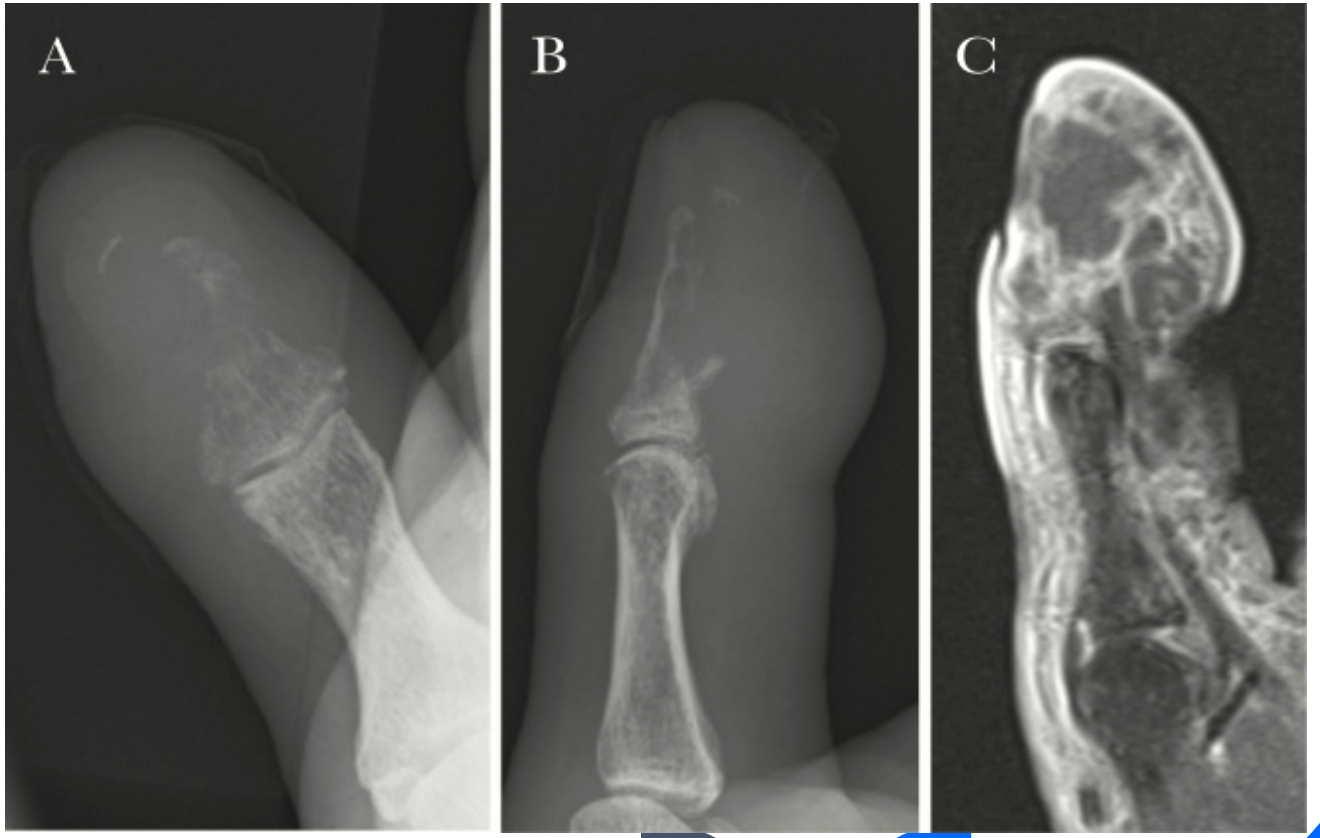


60 year old
with SOB

Malignancy VS Infection

Lung Cancer with mets to thumb

60 year old with osteomyelitis



Clinical Indication Summary

- **Don’t start with – Rule out** – give signs and symptom.
- Give a **location** of the pain/ulcer for MSK studies.
- Don’t ever say:
  - Follow up abnormality
  - Recommended by ----
  - **Never ever just give me CPT code**
- Don’t copy and past impression on prior study.
- Always include history of malignancy and chronic conditions such as crohn’s disease.

2. Principles to Adhere to

You should only order a study if its results will potentially affect patient's management.

YOUR FRIENDLY RADIOLOGIST

Thou shall never say:
”While the patient is in the scanner we might as well scan BLANK.”

YOUR FRIENDLY RADIOLOGIST

YEARLY USA NUMBER OF CTS

	1980	1995	2005	2022
CTS	3 million	20 million	60 million	80 million

Results of a poll of 69 radiologists to the question: What percentage of the studies you read, medically unnecessary?

0% unnecessary - 4 % of responders

20% unnecessary -13 % of responders

40% unnecessary - 31% of responders

60% unnecessary - 62% of responders

Is the increase in CT use good or bad?

- **The GOOD**
  - It has revolutionized Medicine:
    - Decreased the number of exploratory surgeries
    - Made possible to better stage cancer, and see measure response to treatment
    - Improved the accuracy of diagnoses
      - Up to 28% of patients deemed to definitely have acute appendicitis had alternate diagnosis on CT on a recent study. (1)
    - Lots has been done to decrease radiation

Is the increase in CT use good or bad?

- THE BAD
  - Radiation risks or future cancers
  - CT sometimes used in place of physical examination
  - Unnecessary costs and stress

- BAD AND GOOD
  - Incidentalomas
    - adrenal nodules
    - lung nodules
    - ovarian cysts
    - thyroid nodules

Effective radiation dose in adults

Following are comparisons of effective radiation dose in adults with background radiation exposure for several radiological procedures described within this website.

For this procedure:	* An adult's approximate effective radiation dose is:	Comparable to natural background radiation for:
ABDOMINAL REGION:		
Computed Tomography (CT)-Abdomen and Pelvis	10 mSv	3 years
Computed Tomography (CT)-Abdomen and Pelvis, repeated with and without contrast material	20 mSv	7 years
Computed Tomography (CT)-Colonography	6 mSv	2 years
Intravenous Pyelogram (IVP)	3 mSv	1 year
Radiography (X-ray)-Lower GI Tract	8 mSv	3 years
Radiography (X-ray)-Upper GI Tract	6 mSv	2 years
BONE:		
Radiography (X-ray)-Spine	1.5 mSv	6 months
Radiography (X-ray)-Extremity	0.001 mSv	3 hours
CENTRAL NERVOUS SYSTEM:		
Computed Tomography (CT)-Head	2 mSv	8 months
Computed Tomography (CT)-Head, repeated with and without contrast material	4 mSv	16 months
Computed Tomography (CT)-Spine	6 mSv	2 years
CHEST:		
Computed Tomography (CT)-Chest	7 mSv	2 years

Chest x-ray = 10 mrem

Chest CT= 700 mrem= 70 chest x-rays

Abdomen and pelvis CT = 1400 mrem = 140 chest x-rays

Head CT = 200 mrem = 20 chest x-rays

Medical Tests

Medical Diagnostic Tests ‡

Number of millirems are per procedure and are average values. Actual numbers may vary.
Enter the number of procedures per year.

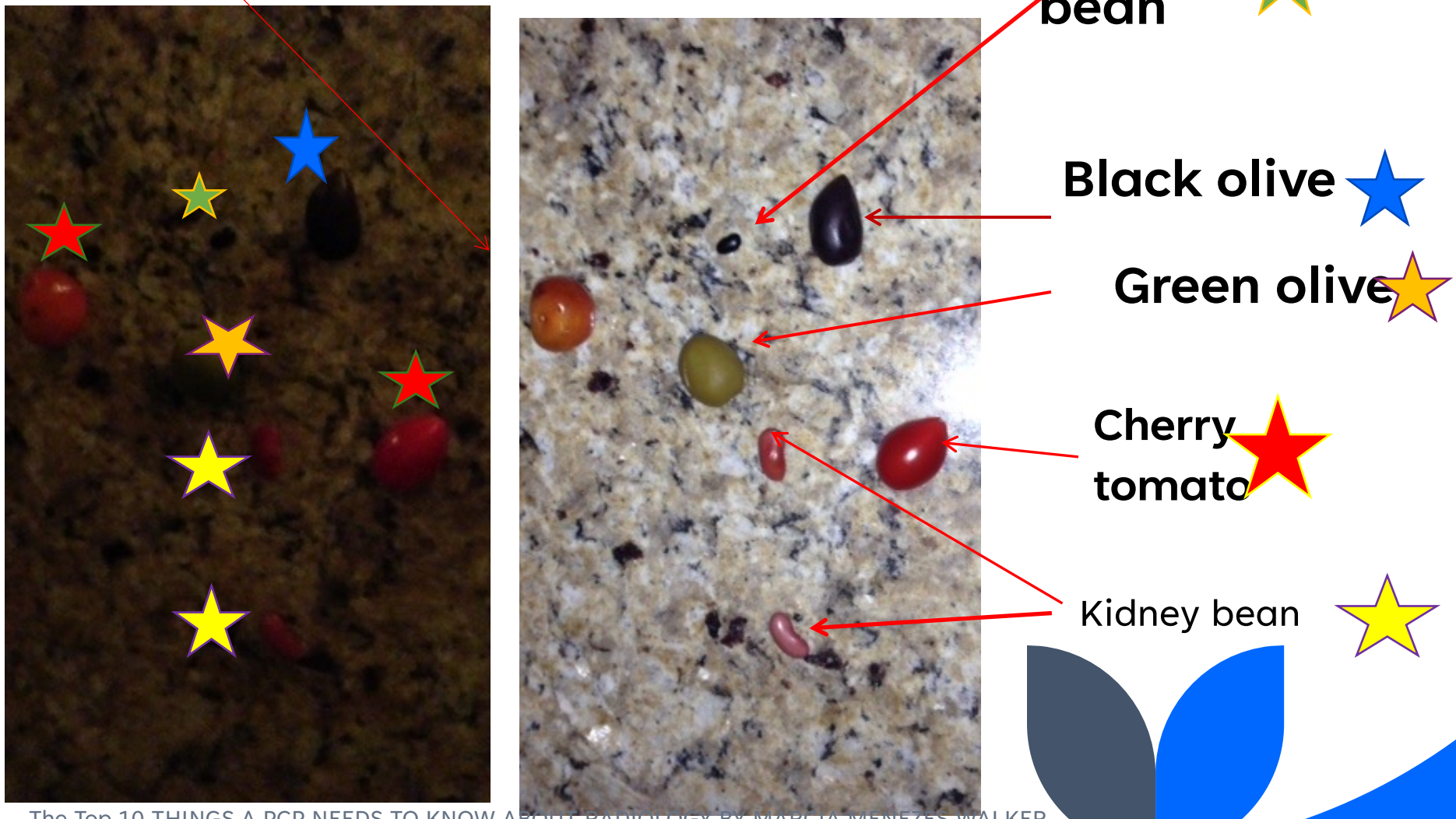
X-Ray - Chest		(10 mrem)	0 mrem
X-Ray - Mammography		(40 mrem)	0 mrem
X-Ray - Skull		(10 mrem)	0 mrem
X-Ray - Cervical Spine		(20 mrem)	0 mrem
X-Ray - Lumbar Spine		(600 mrem)	0 mrem
X-Ray - Upper GI		(600 mrem)	0 mrem
X-Ray - Abdomen (kidney/bladder)		(70 mrem)	0 mrem
X-Ray - Barium Enema		(800 mrem)	0 mrem
X-Ray - Pelvis		(60 mrem)	0 mrem
X-Ray - Hip		(70 mrem)	0 mrem
X-Ray - Dental Bitewing/Image		(0.5 mrem)	0 mrem
X-Ray - Extremity (hand/foot)		(0.1 mrem)	0 mrem
CT Scans - Head		(200 mrem)	0 mrem
CT Scans - Chest		(700 mrem)	0 mrem
CT Scans - Abdomen		(800 mrem)	0 mrem
CT Scans - Pelvis		(600 mrem)	0 mrem
CT Scans - Extremity		(10 mrem)	0 mrem
CT Scans - Angiography (heart)		(1200 mrem)	0 mrem
CT Scans - Angiography (head)		(1000 mrem)	0 mrem
CT Scans - Spine		(600 mrem)	0 mrem
CT Scans - Whole Body		(1275 mrem)	0 mrem
CT Scans - Cardiac		(300 mrem)	0 mrem

Information from the American Nuclear Society

#3 CONTRAST
OR
NO CONTRAST
THAT IS THE QUESTION

Intravenous contrast

It is like turning the lights on.



IV CONTRAST

- NOT ALL CT WITH CONTRAST ARE DONE THE SAME WAY
  - We give contrast and the machine starts scanning after a set amount if time
- Typical phases:

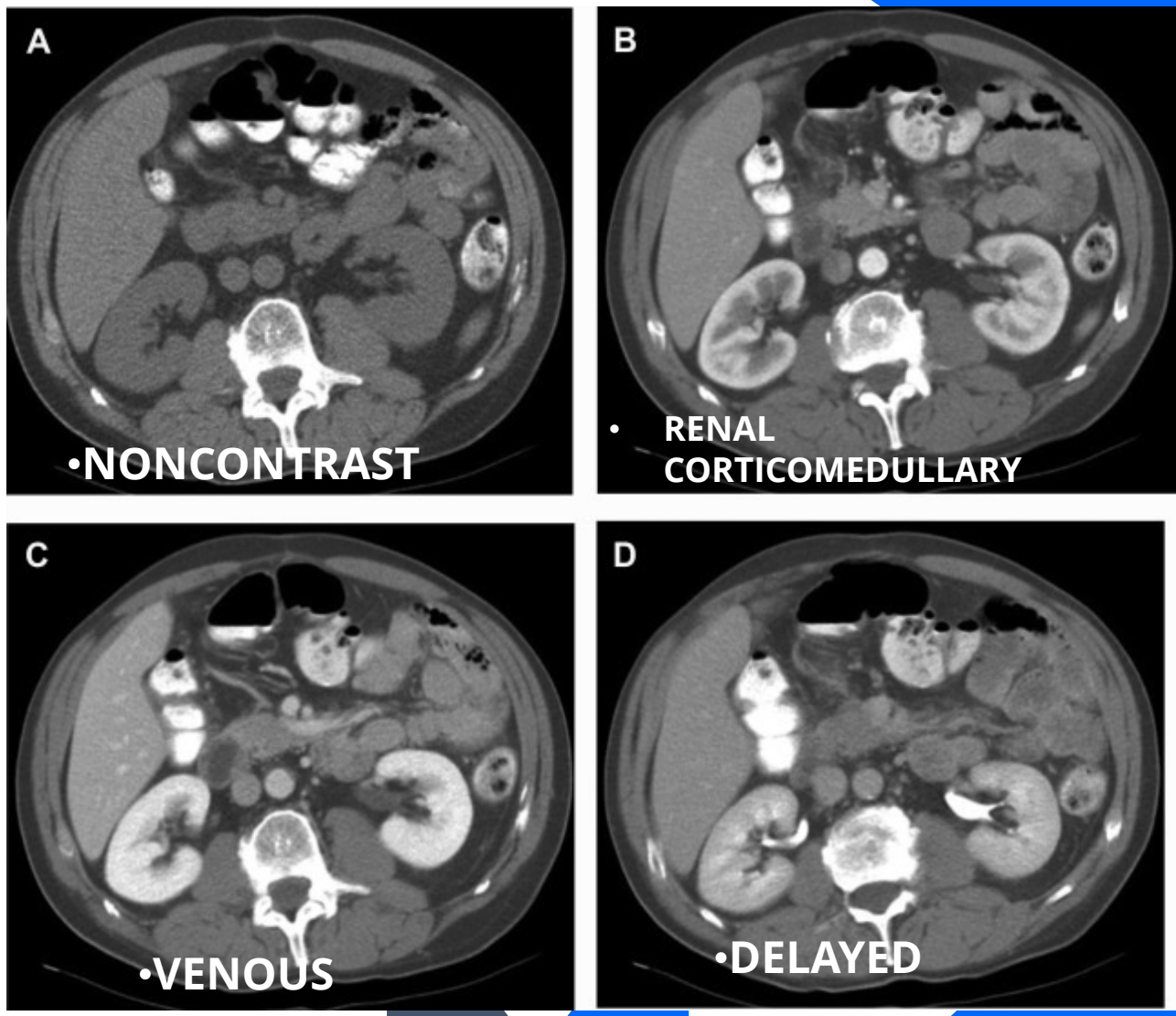
  ARTERIAL 15-40 SEC

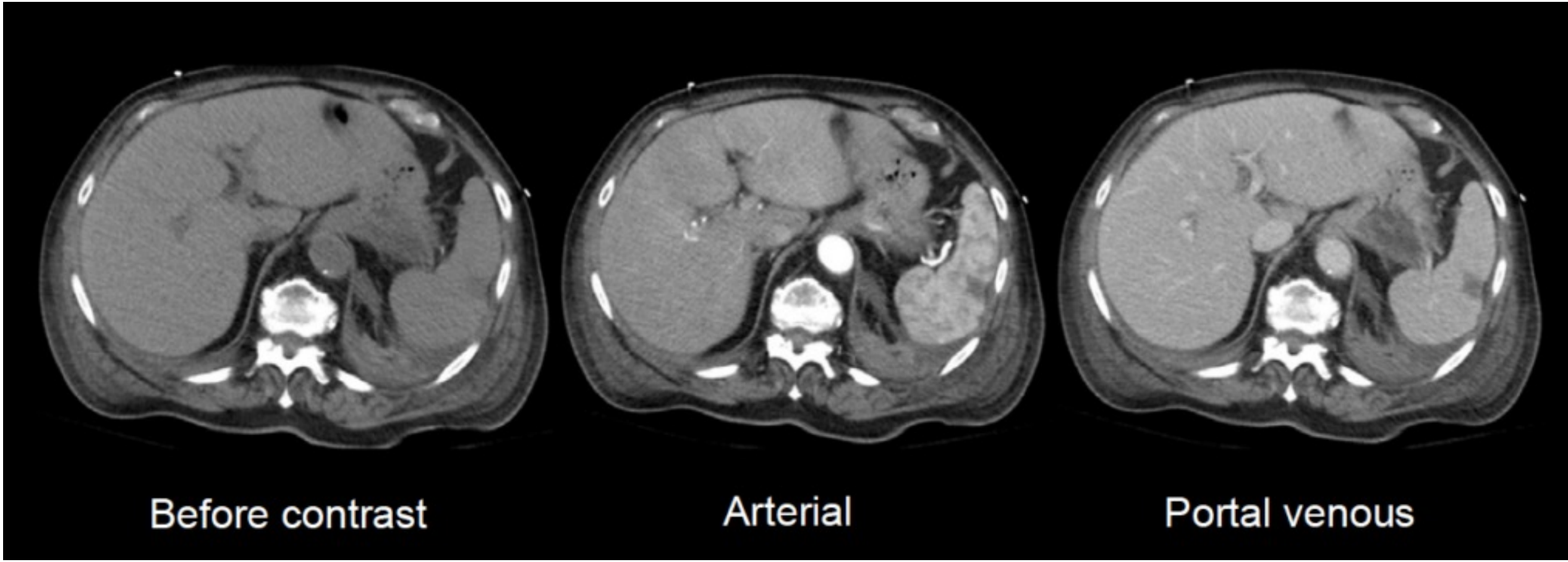
  RENAL CORTICOMEDULLARY 40-70 SEC

  PORTAL VENOUS PHASE 70-90 SEC

  NEPHROGENIC PHASE 85-120 SEC

  EXCRETORY PHASE 5-10 MIN




Before contrast
Arterial
Portal venous

TOP 10 THINGS ABOUT CT IV CONTRAST PCP NEEDS TO KNOW

1. **Patients on permanent dialysis can have contrast.**
   - Considerations:
     - CHF (severe CHF Low ejection fraction) -
     - Still make urine – consult nephrology
2. **Allergy to shellfish is not a contraindication to IV contrast.**
3. **Allergy to MRI contrast does not equate to allergy to CT contrast.**
4. **Patients with true allergy require 13 hour premeds unless it is an emergency (ACR recommendation)**

   13-7-1 50 mg of oral prednisone

   1 hour – 50 mg of Benadryl

CARDS CAN BE DOWNLOADED FREE FROM ACR MANUAL ON CONTRAST

ACR American College of Radiology

ADULT

CODE BLUE #:

EXAMPLE PREMEDICATION REGIMENS

Methylprednisolone 32 mg PO 12, 2 hrs prior +/- Benadryl 50 mg PO 1 hr prior.
OR
Prednisone 50 mg PO 13, 7, 1 hours prior
+/- Benadryl 50 mg PO 1 hr prior.
OR
Hydrocortisone 200 mg IV 5 hrs and 1 hr prior and Benadryl 50 mg IV 1 hr prior.
(urgent, NPO only, ER, inpatient)

CONTRAST EXTRAVASATION

Elevate arm (heart level), apply cool compress, remove rings. Observe. Consider surgical consultation for decreased perfusion, sensation, strength, active range of motion, or increasing pain.

Document reaction & monitor for return of symptoms post-treatment

HIVES/DIFFUSE ERYTHEMA

1. Observation; monitor vitals q 15 min. Preserve IV access.
2. If associated with hypotension or respiratory distress then considered **Anaphylaxis**:
   - O_2 6-10 L/min by face mask
   - IVF 0.9% NS wide open; elevate legs > 60°
   - Epinephrine 0.3 mL of 1mg/mL IM (or auto-injector) OR Epinephrine 1 mL of 1mg/10mL (0.1 mg/mL) IV with slow flush or IV fluids
   - **Call 911** or **CODE BLUE**
3. If *ONLY* skin findings but severe or progressive may consider Benadryl 50 mg PO, IM, IV but may cause or worsen hypotension.

HYPOTENSION WITH TACHYCARDIA (ANAPHYLAXIS)

1. Preserve IV access, monitor vitals q 15m
2. O_2 6-10 L/min by face mask
3. Elevate legs > 60°
4. IVF 0.9% NS wide open
5. Epinephrine 0.3 mL of 1mg/mL IM (or auto-injector) OR Epinephrine 1 mL of 1mg/10mL (0.1 mg/mL) IV with slow flush or IV fluids
6. **Call 911** or **CODE BLUE**

HYPOTENSION WITH BRADYCARDIA

1. Preserve IV access; monitor vitals
2. O_2 6-10 L/min by face mask
3. Elevate legs > 60°
4. IVF 0.9% NS wide open
5. Atropine 0.6-1.0 mg IV if refractory
6. **Consider calling 911** or **CODE BLUE**

ADULT

LARYNGEAL EDEMA (INSPIRATORY STRIDOR)

1. Preserve IV access, monitor vitals
2. O_2 6-10 L/ min by face mask
3. Epinephrine 0.3 mL of 1mg/ mL IM (or auto-injector) OR Epinephrine 1 mL of 1mg/10mL (0.1 mg/mL) IV with slow flush or IV fluids
4. **Call 911** or **CODE BLUE**

BRONCHOSPASM (EXPIRATORY WHEEZE)

1. Preserve IV access, monitor vitals
2. O_2 6-10 L/min by face mask
3. Beta-2 agonist inhaler 2 puffs; repeat x 3
4. If not responding or severe, then use Epinephrine 0.3 mL of 1mg/ mL IM (or auto-injector) OR Epinephrine 1 mL of 1mg/10mL (0.1 mg/mL) IV with slow flush or IV fluids
5. **Call 911** or **CODE BLUE**

TOP 10 THINGS ABOUT CT IV CONTRAST PCP NEEDS TO KNOW

5. **Risks for contrast reaction:**
   - Prior allergic-like reaction- not absolute predictor
     - Estimated risk when non premedicated - 10 to 35%
   - **Patients with asthma or multiple allergies**
     - Risk less probably less than 10-35% when nonpredimedicated
     - We are regularly recommending premeds for patients with multiple allergies
6. **Patients with prior anaphylaxis**
   - Shall have IV contrast only if no other study will work and **a physician is present to intubate** the patient if needed.

TOP 10 THINGS ABOUT CT IV CONTRAST PCP NEEDS TO KNOW

7. Previously thought conditions to be at high risk have been determined to have little evidence of that:
   - Myasthenia gravis, phechromocytosis, thyrotoxicosis, or sickle-cell disease

TOP 10 THINGS ABOUT CT IV CONTRAST PCP NEEDS TO KNOW

8. ACR manual support patients with **GRF greater than 30 receiving contrast**
   - Here is the wording of the ACR:
     - CA-AKI – sudden deterioration of kidney function occurring 48 hour after contrast – This may occur regardless of the contrast.
     - CI-AKI – AKA Contrast induced nephropathy – specific term used to describe sudden deterioration of renal function caused by the contrast. This is a subcategory of CA-AKI.
     - **CI-AKI an CA-AKI are not synonymous.**
     - **"At the current time (2023), it is the position of the ACR Committee on Drug and contrast media that CI-AKI is real, albeit rare, entity. Published studies on CI-AKI (not CA-AKI) have been heavily contaminated by bias and conflation. Future investigation building on recent methodological advances are necessary to clarify the incidence and significance of this disease."**

TOP 10 THINGS ABOUT IV CONTRAST

9. I can rarely see a PE without IV contrast.
    - When I do a PE study, I can see the lungs just as well.

10. Any concern for **malignancy, abscess** require IV contrast.

MARCIA MENEZES WALKER

BOARD CERTIFIED

RADIOLOGIST

FELLOWSHIP

IN BODY IMAGING

Contrast Summary

1. Contrast studies are done differently – I need to know the clinical picture and the organ you suspect an abnormality.
2. Any infection/abscess requires contrast.
3. Patients on dialysis can have contrast
4. Prior contrast reaction – need to know the reaction
    1. Almost Never give contrast after anphylaxis
5. Premedicate prior reactions and multiple other reactions

Contrast Summary

6. Patients with GFR greater than 30 can get contrast.
7. Previous rare conditions such as pheochromocytosis are not at high risk of contrast reaction/.
8. PE requires contrast – I can also evaluate the rest of lung
9. Any concern for malignancy requires contrast.
10. Really skinny patient needs IV and oral contrast.

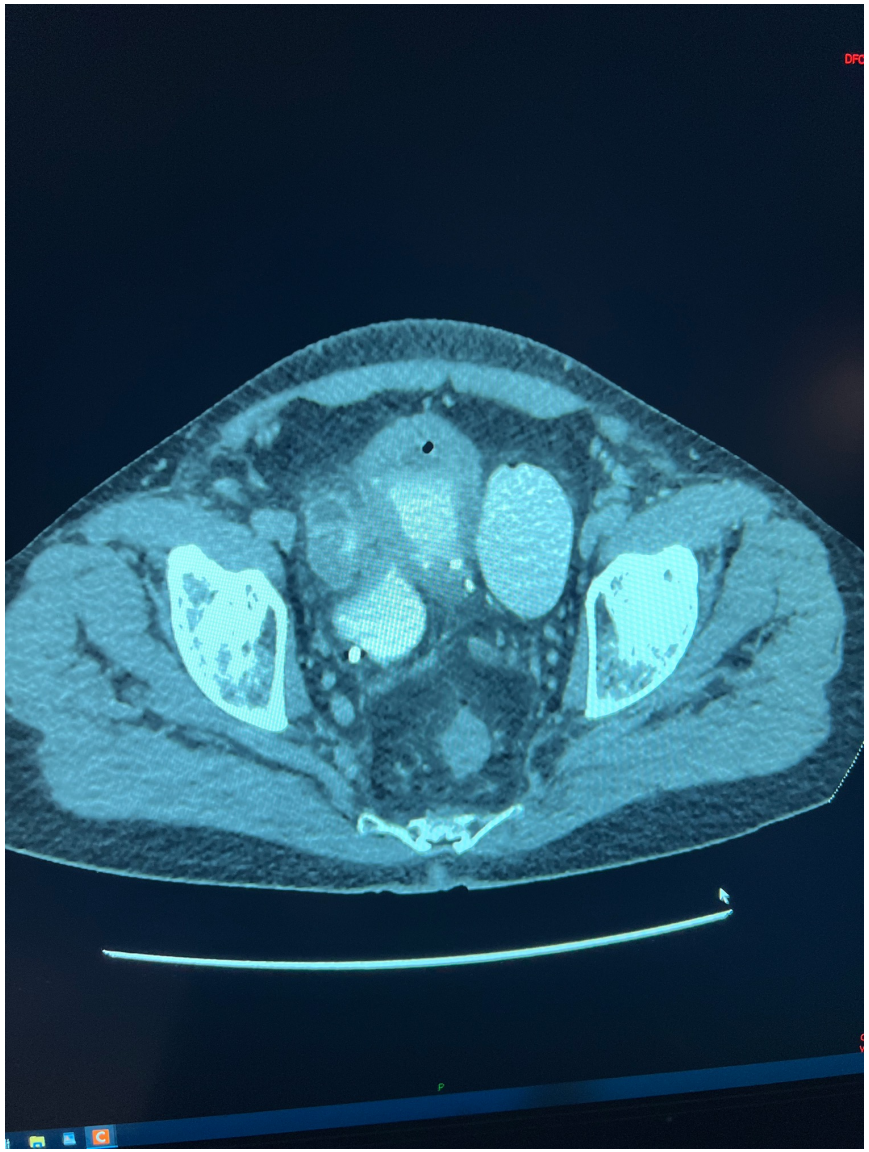
#4 ORDER THE CORRECT STUDY

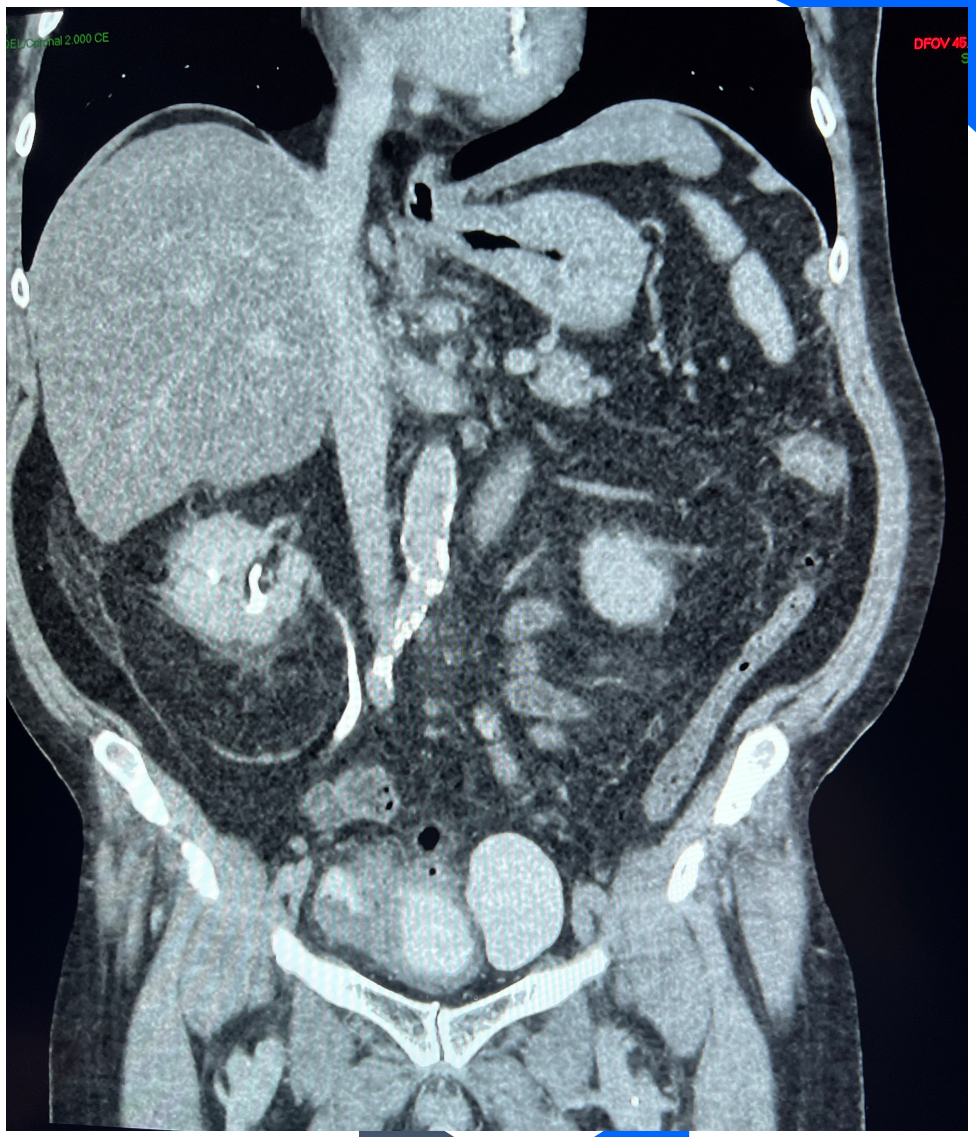
#4 Order the Correct Study

- **Rarely order Abdomen CT only (Rather than Adomen and Pelvis)**
  - **Even if pain is in** Abdomen only
  - Order abdomen only when patient has know pathology in abdominal organ: Liver, kidneys, pancreas.

#4 Order the Correct Study

- **Older Adults** with **painless hematuria** deserve an CT urogram protocol, not an US:
  - What are you going to find in US that would stop you from having to order a CT?
    - US does not see ureters very well
  - UTI is most common cause of hematuria
  - Enlarged prostate is one of most common pathologies for hematuria in older man –
    - however one must rule out malignancy





Urothelial carcinoma in a bladder diverticulum

You are working in your office in the Saint Elsewere hospital. What you order?

35 year old with BMI=29 with RLQ pain, N/V and a fever

Maria Silva

A. Pelvic Ultrasound.
B. CT with IV contrast plus oral
C. CT with IV contrast only
D. CT without any contrast
E. MRI without contrast
F. KUB

60 year old hx of breast cancer with chest pain SOB, and hypoxic, with normal chest xray with prior anaphylaxis with contrast

EXAMPLE PREMEDICATION REGIMENS

Methylprednisolone 32 mg PO 12, 2 hrs prior +/- Benadryl 50 mg PO 1 hr prior.
OR
Prednisone 50 mg PO 13, 7, 1 hours prior
+/- Benadryl 50 mg PO 1 hr prior.
OR
Hydrocortisone 200 mg IV 5 hrs and 1 hr prior and Benadryl 50 mg IV 1 hr prior.
(urgent, NPO only, ER, inpatient)

A. Chest Ultrasound
B. CT Chest with contast
C. CTA Chest with IV contrast
D. MRI Chest without contrast
E. KUB
F. None of the above

Accelerated premeds and anesthesia present at the scanner ready to intubate

35 year with hx of kidney stone and right flank pain and says that feels like another stone

- Rakesh Santoshi

A. Renal Ultrasound.
B. CT without IV contrast with oral
C. CT with IV contrast without oral
D. No test – just treat
E. KUB

ACR appropriateness cr

Diagnostic Imaging Updates

1. Acute Pyelonephritis
2. Ataxia - child
3. Central Venous Access Device and Site Selection (Revised)
4. Chronic elbow pain
5. Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis, Crystalline Arthritis, or Erosive Osteoarthritis (Revised)
6. Chronic hip pain
7. Chronic shoulder pain
8. Cranial Neuropathy (Revised)
9. Evaluation of Nipple Discharge (Revised)
10. Fibroids (New)
21. Osteoporosis and Bone Mineral Density (Revised)
22. Palpable Breast Masses (Revised)
23. Pretreament detection, surveillance, & staging of Prostate cancer
11. Headache
12. Hernia (New)
13. Imaging after breast surgery
14. Imaging of Deep Inferior Epigastric Arteries for Surgical Planning (Breast Reconstruction Surgery) (Revised)
15. Lower Extremity Arterial Claudication-Imaging Assessment for Revascularization (Revised)
16. Lung Cancer Screening (Revised)
17. Malignant or aggressive Primary MSK tumor, staging and surveillance
18. Management of vertebral compression Fracture
19. Monitoring Response to Neoadjuvant Systemic Therapy for Breast Cancer (Revised)
20. Osteonecrosis

ACR appropriateness criteria

RLQ pain Table

Without Signs of Acute Appy

Variant 1: **Right lower quadrant pain. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	Best choice
US abdomen	May Be Appropriate	Maybe Depends on situation
US pelvis	May Be Appropriate	
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	
MRI abdomen and pelvis without IV contrast	May Be Appropriate	
CT abdomen and pelvis without IV contrast	May Be Appropriate	
Radiography abdomen	Usually Not Appropriate	Stay away from these
Fluoroscopy contrast enema	Usually Not Appropriate	
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	
WBC scan abdomen and pelvis	Usually Not Appropriate	

ACR appropriateness criteria RLQ pain Table

Variant 2: **Right lower quadrant pain, fever, leukocytosis.**

Suspected appy initial Imaging

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	
CT abdomen and pelvis without IV contrast	May Be Appropriate	
US abdomen	May Be Appropriate	
US pelvis	May Be Appropriate	
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	
MRI abdomen and pelvis without IV contrast	May Be Appropriate	
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	
Radiography abdomen	Usually Not Appropriate	
WBC scan abdomen and pelvis	Usually Not Appropriate	
Fluoroscopy contrast enema	Usually Not Appropriate	

Best choice

Maybe
Depends on situation

Stay away from these

#4 Order the Correct Study
When Not to Order an US?

- Use Complete US abdomen with caution
  - US is very operator dependent
  - Not sensitive for renal and liver lesions
  - Caution about US in morbidly obese patient
- Not for diffuse abdominal pain
- **Never for the Pancreas in adults**
- **Never for adrenal glands**
- **Never for a jaundice patient**
  - **Cancer till proven otherwise**

#4 Order the Correct Study
When does patient need an US?

*ok

- BASICALLY SUPPERFICIAL ORGANS
  - Concern for a DVT
  - Carotid artery concerns
  - Thyroid
  - Children
  - Testicles
  - RUQ pain
  - Renal Ultrasound in some cases
    - Looking for hydro
    - Not great for renal mass

#4 Order the Correct Study
When not to order X-Ray?

- Rarely order a KUB for abdominal pain for adult unless:
  - You are in location where CT is not in the building/location
  - Follow-up for renal stone position
  - Determine degree of constipation without abdominal pain
- **Patient with flank pain - don't oder US or Xray**
- **Follow-up lung nodules**
- **Follow-up tumor anywhere**

#4 Order the Correct Study
When you need to order X-Ray?

- A joint pain/trauma should start with an X-ray even if you are going to order MRI
- Follow-ups of fracture should be with X-ray

#5 FOLLOW-UP GUIDELINES

#4 Follow-up Guidelines

- Rib fractures do not require F/U
- Imaging sooner is not better
  - Lymphadenopathy usually takes at least 3 months to resolve
  - Pneumonia takes 4 to 6 weeks to resolve.
    - Patient who is improving does not need radiograph every other day
  - There are criteria that we follow – liabilities with not following that
  - Don’t pick stuff from the body of the report and not in impression to order F/u
    - If somethings seems concerning – call the radiologist

ACR WHITE PAPER INCIDENTALOMAS

Managing Incidental Findings on Thoracic CT: Lung Findings. A White Paper of the ACR Incidental Findings Committee
Management of Incidental Adnexal Findings on CT and MRI: A White Paper of the ACR Incidental Findings Committee
Managing Incidental Findings on Thoracic CT: Mediastinal and Cardiovascular Findings
Management of Incidental Pituitary Findings on CT, MRI, and 18F-Fluorodeoxyglucose PET: A White Paper of the ACR Incidental Findings
Management of Incidental Pancreatic Cysts: A White Paper of the ACR Incidental Findings Committee
Management of Incidental Adrenal Masses: A White Paper of the ACR Incidental Findings Committee
Management of the Incidental Renal Mass on CT: A White Paper of the ACR Incidental Findings Committee

ACR WHITE PAPER INCIDENTALOMAS

Management of Incidental Liver Lesions on CT: A White Paper of the ACR Incidental Findings Committee

Managing Incidental Thyroid Nodules Detected on Imaging: White Paper of the ACR Incidental Thyroid Findings Committee

Overview of White Papers of the ACR Incidental Findings Committee II on Adnexal, Vascular, Splenic, Nodal, Gallbladder, and Biliary Findings

Managing Incidental Findings on Abdominal and Pelvic CT and MRI, Part 1: White Paper of the ACR Incidental Findings Committee II on Adnexal Findings

Managing Incidental Findings on Abdominal and Pelvic CT and MRI, Part 2: White Paper of the ACR Incidental Findings Committee II on Vascular Findings

Managing Incidental Findings on Abdominal and Pelvic CT and MRI, Part 3: White Paper of the ACR Incidental Findings Committee II on Splenic and Nodal Findings

Managing Incidental Findings on Abdominal and Pelvic CT and MRI, Part 4: White Paper of the ACR Incidental Findings Committee II on Gallbladder and Biliary Findings

Managing Incidental Findings on Abdominal CT: White Paper of the ACR Incidental Findings Committee

#6 ABREVIATIONS

#6 ABBREVIATIONS

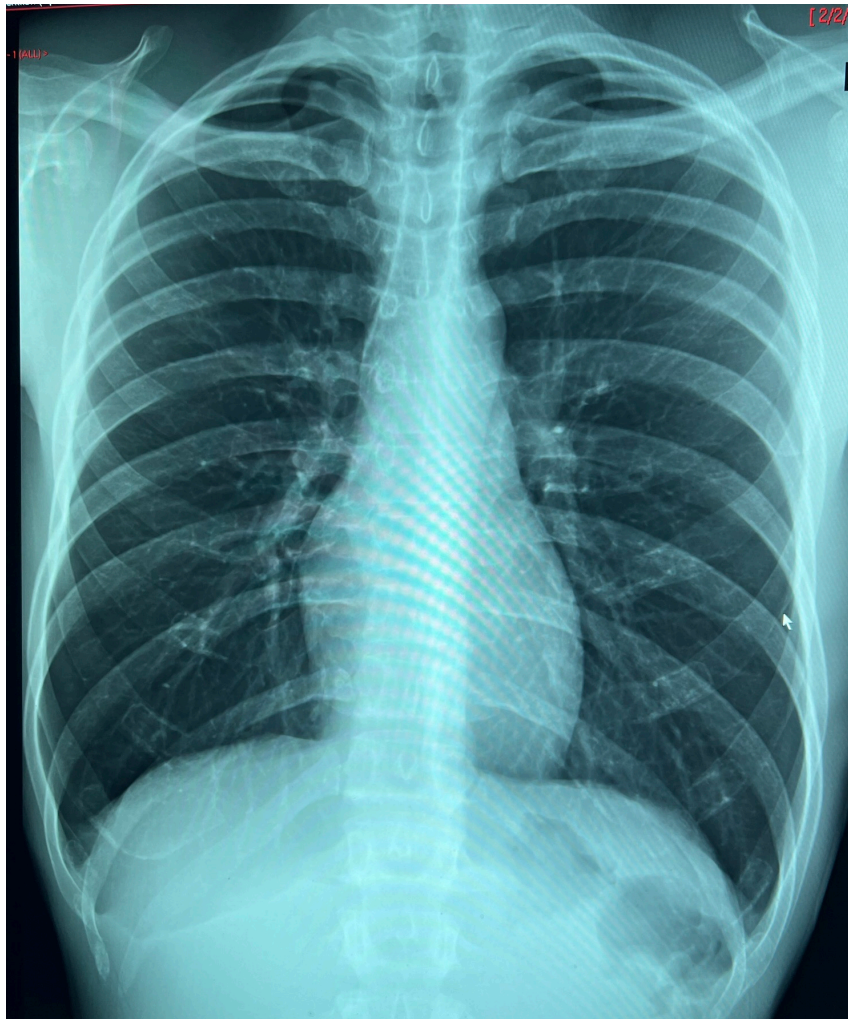
JUST DON'T USE THEM, PERIOD, END FULL STOP.

I WASTE SO MUCH TIME LOOKING UP ABBREVIATION – WHAT YOU THINK EVERYONE KNOWS – NOT EVERYONE KNOWS

#7 HUMBLE CHEST XRAY

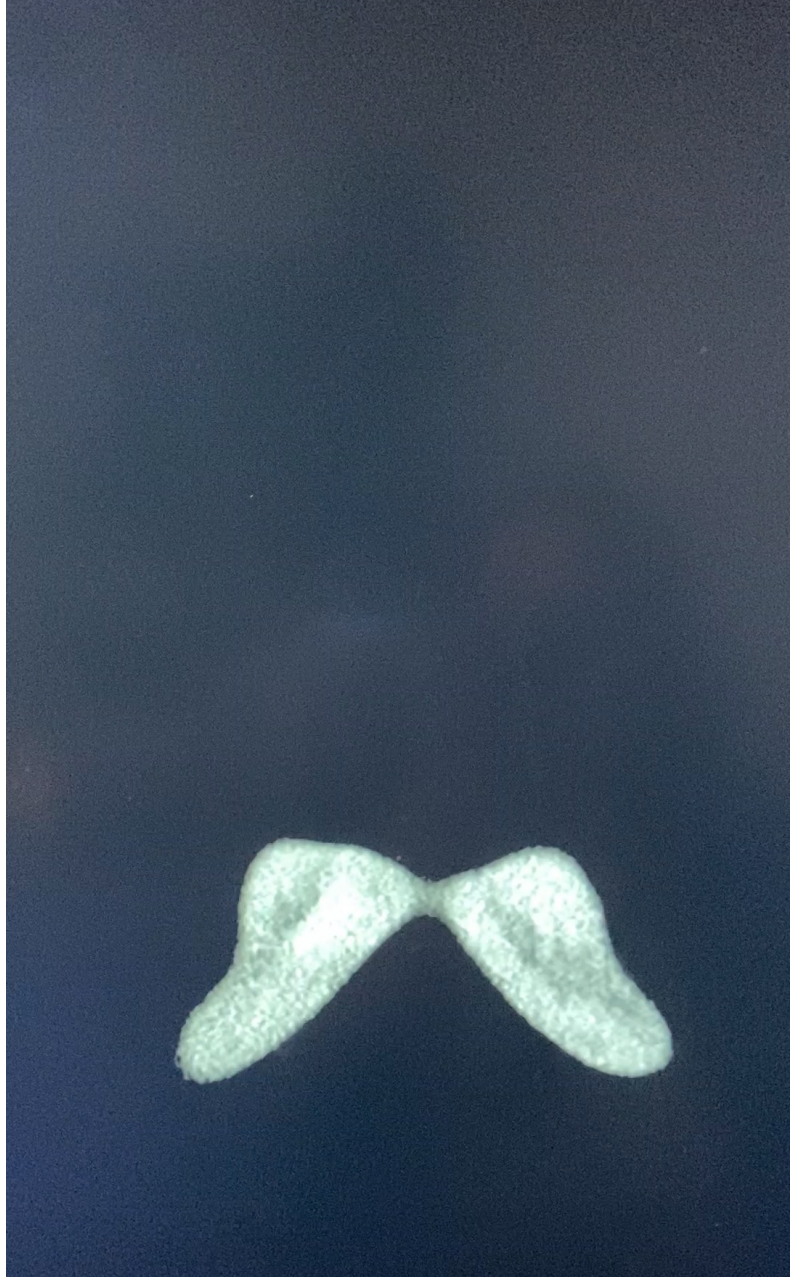
#7 -THE HUMBLE CHEST X-RAY

- When stone cold normal it is easy.
  - Uncommon in population over 65.
- Follow up on the cases that the rad recommended a chest CT
  - See what the abnormality turned out to be
- Never get overconfident
  - A chest xray can hide a multitude of nodules, lymph nodes.
  - Always read the final radiology report



Stone cold chest Radiograph

3rd year case 65 YO WITH COUGH



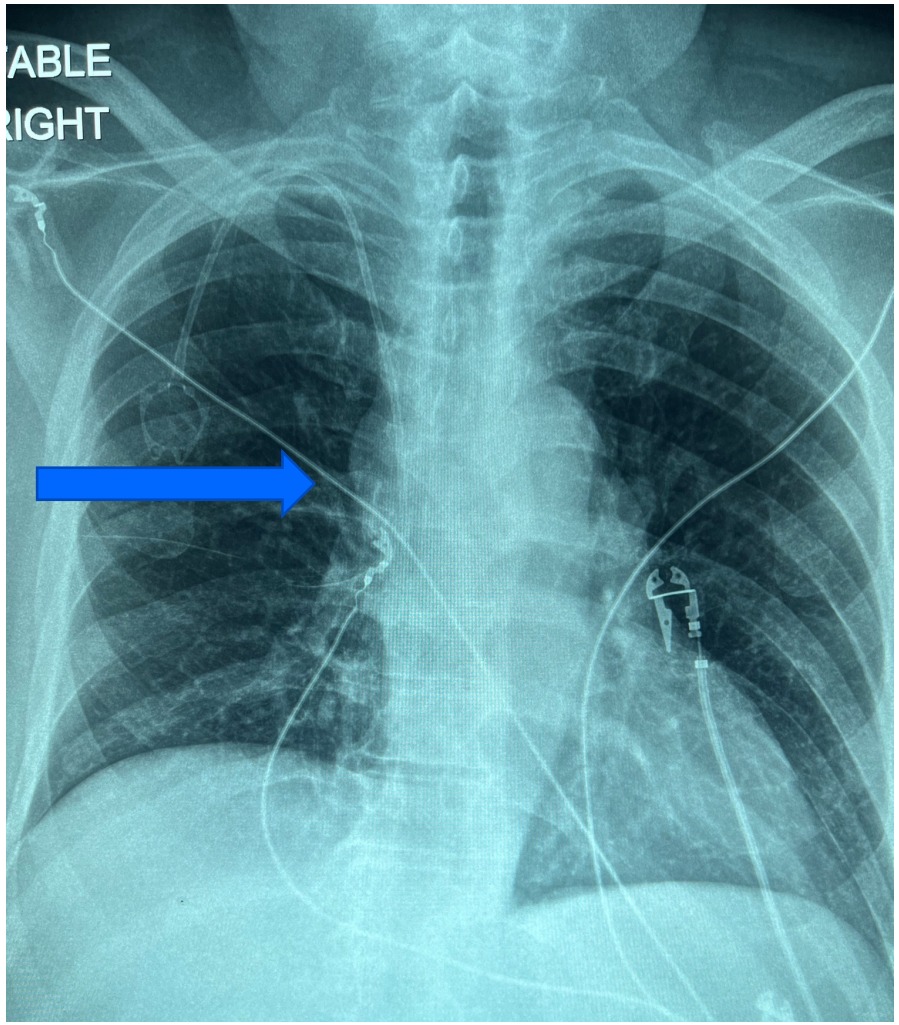
3rd year case

stop

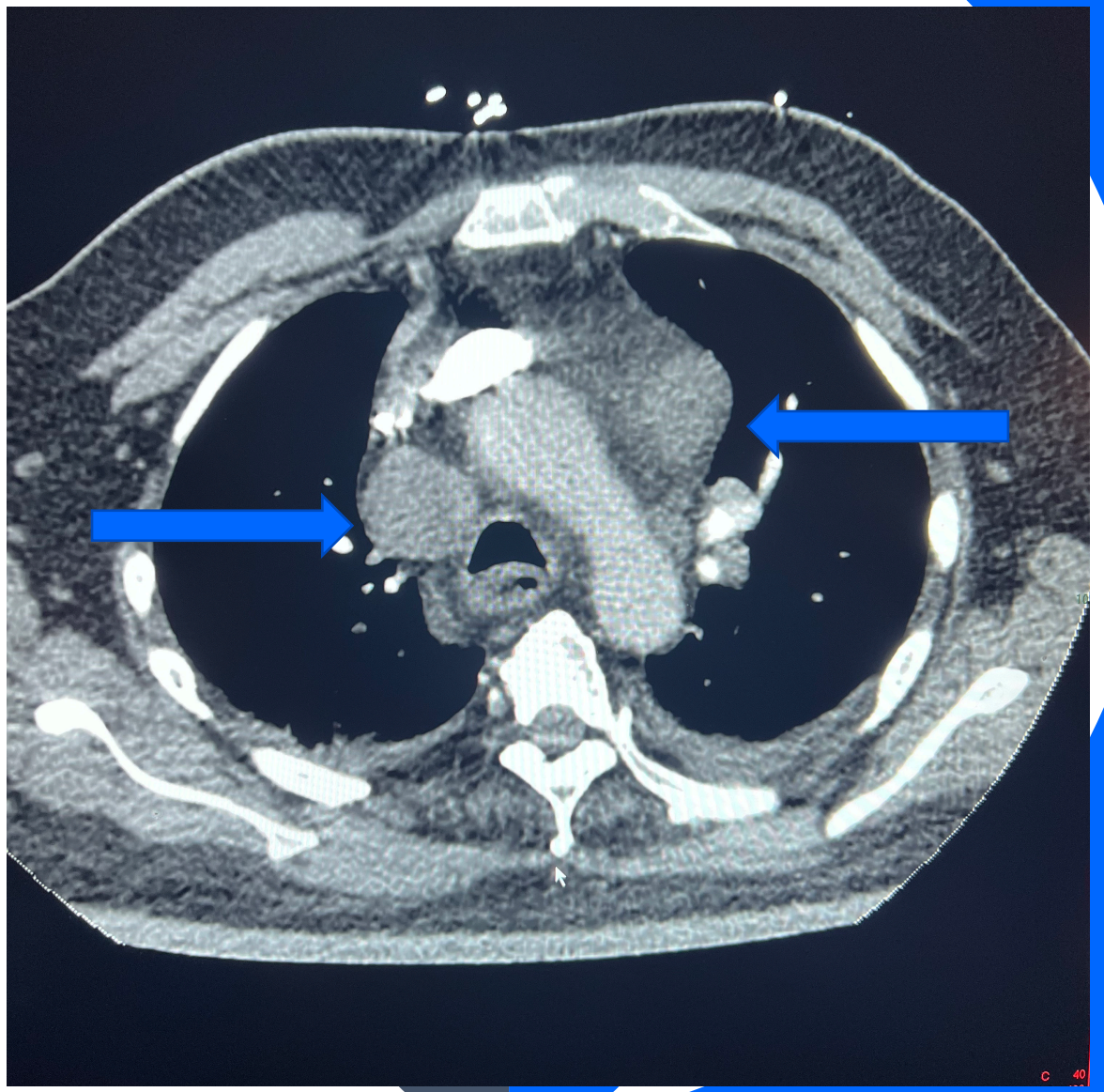
65 YO – Dialysis catheter position

What would your report say?

Mediastinal bulky lymphadenopathy

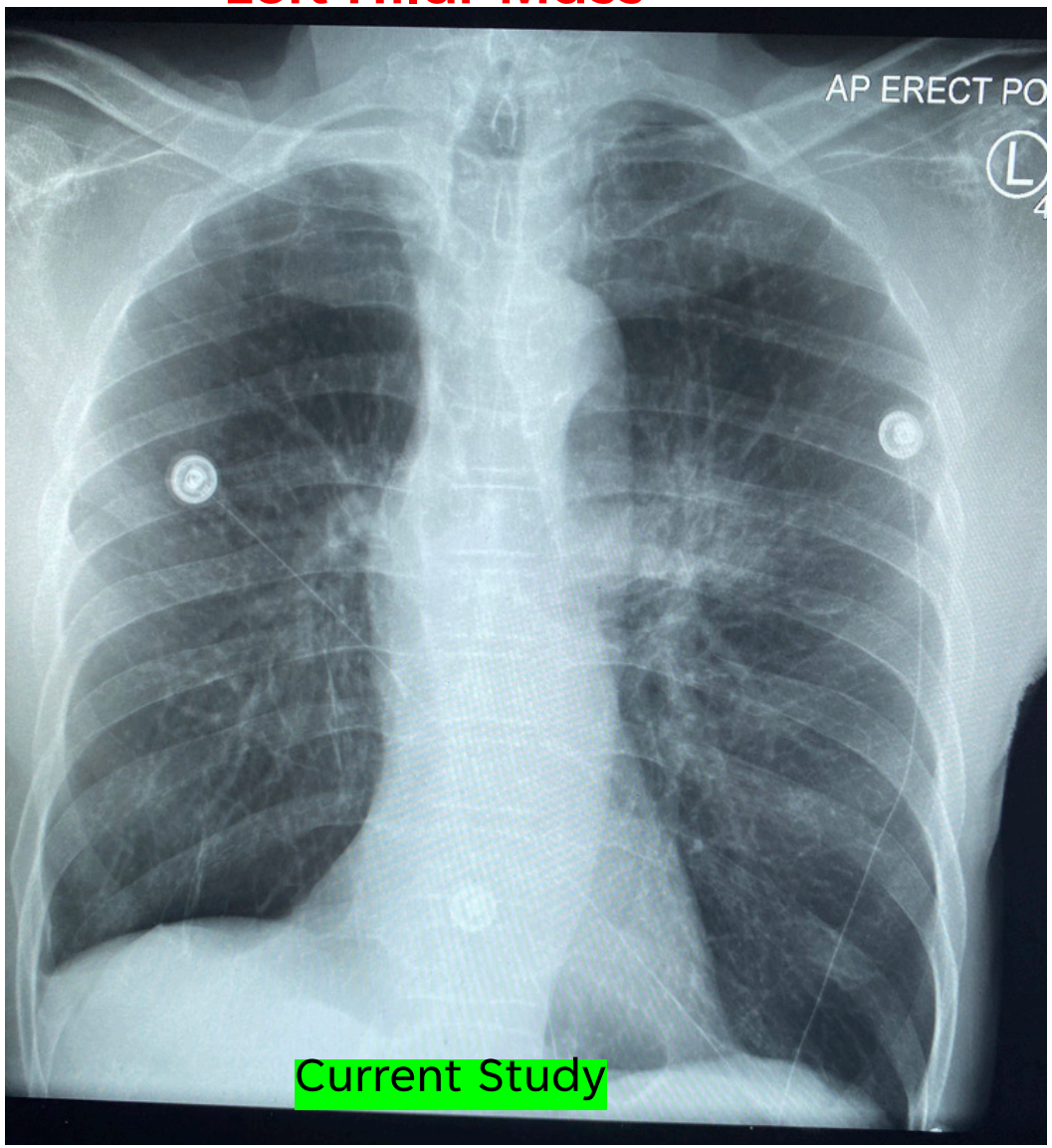


Catheter in adequate position

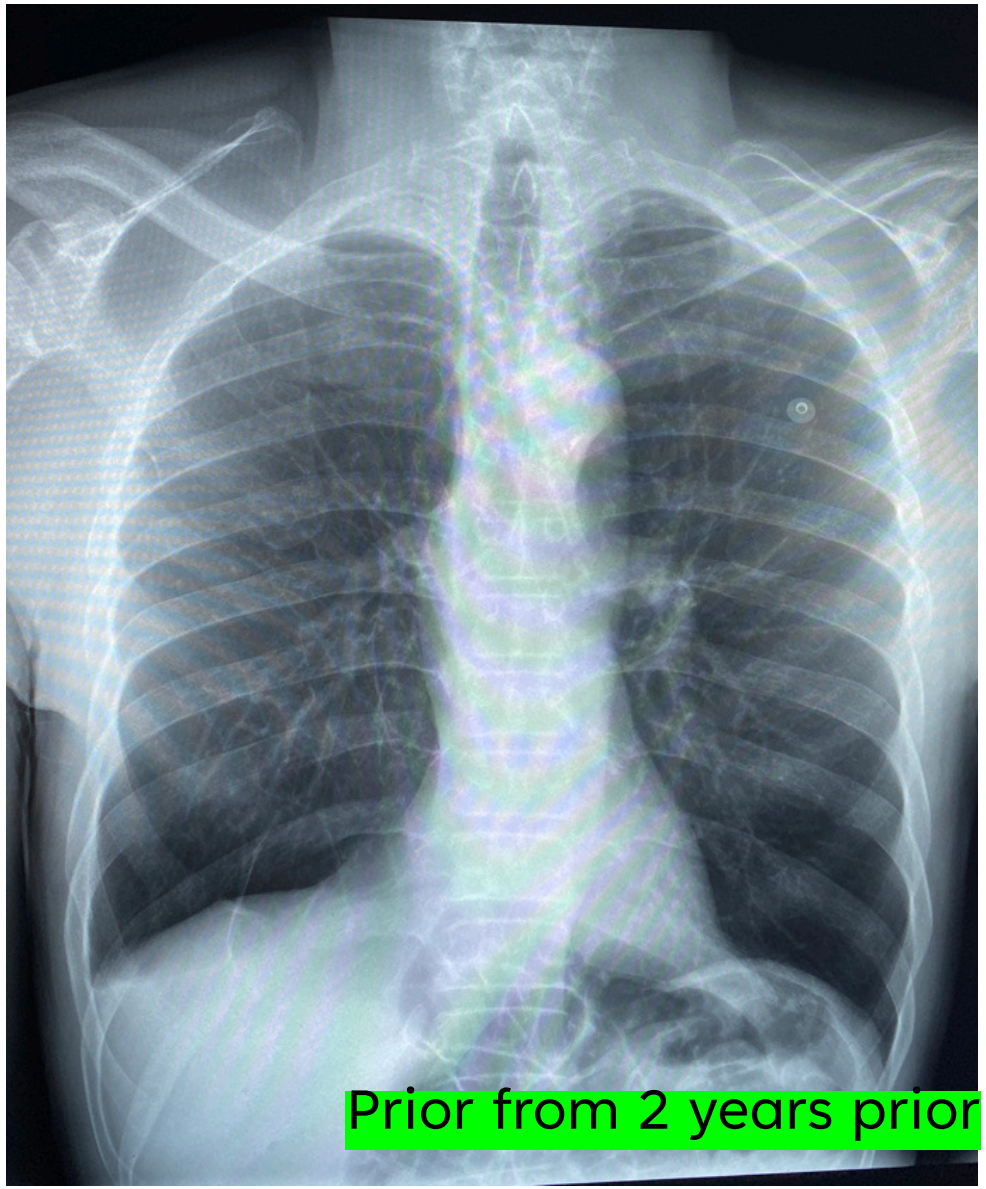


Prior studies are your friends

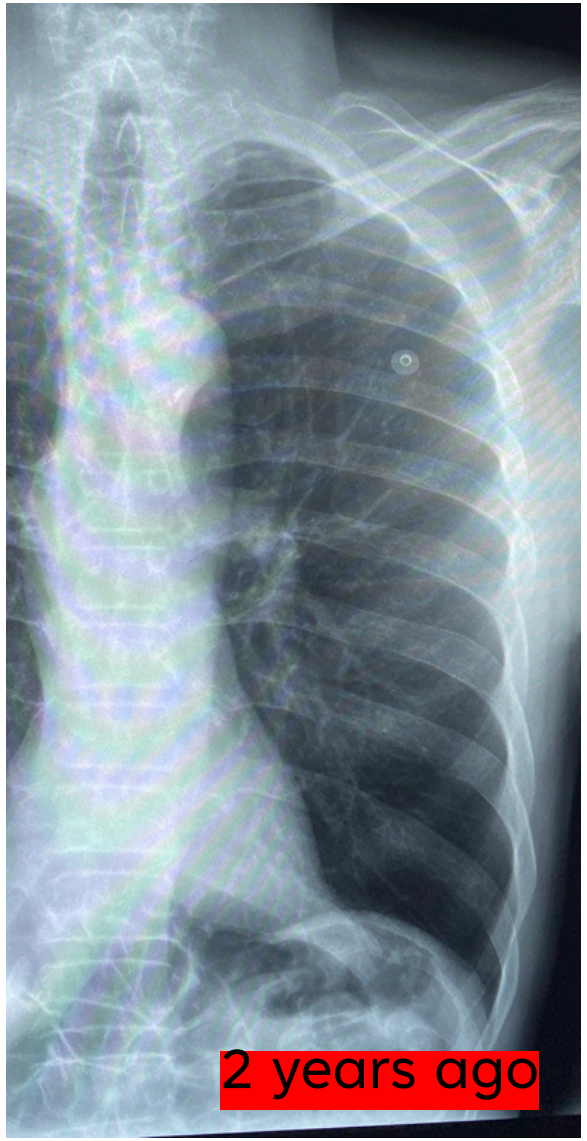
Left Hilar Mass stop

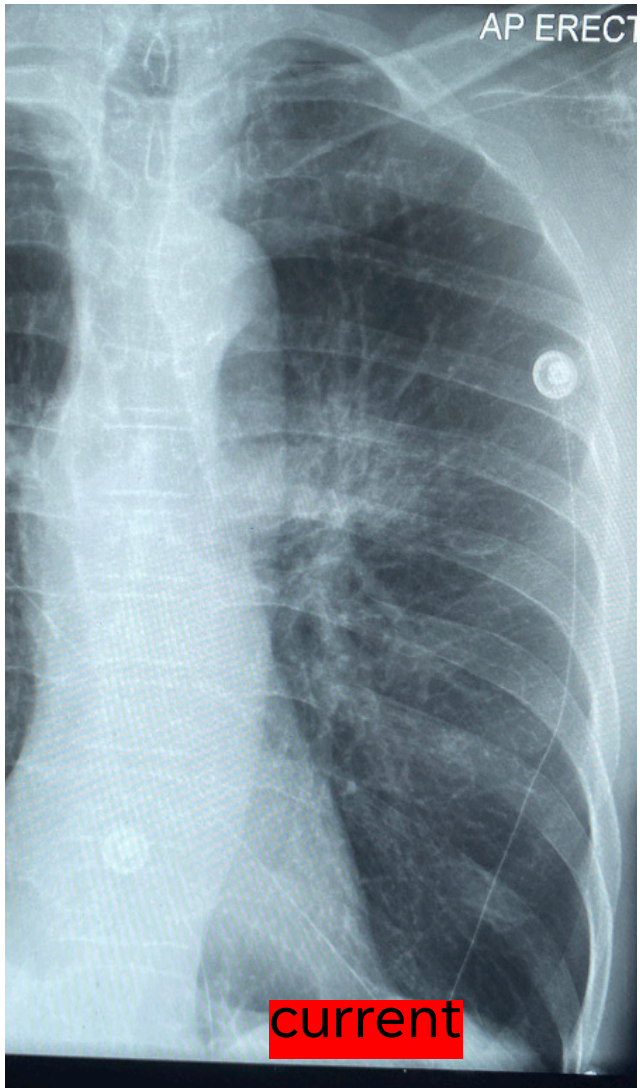


75 yo chest xray for housing clearance



PROGRESSION – DON'T LOOK JUST AT THE MOST RECENT PRIOR





#8 LUNG CANCER SCREENING AND INCIDENTAL LUNG NODULES

8 – LUNG CANCER SCREENING

- **ELIGIBILITY**
  - •Are **50 to 80 years old and in fairly good health**, and
  - •Currently smoke
  - •Have at least 20 pack-years smoking history
  - **•No personal hx of lung cancer**
  - **•Asymptomatic**
- **Counseling and Shared Decision-**
  - **IMPORTANCE OF:**
  - **Maintaining cigarette smoking abstinence if former smoker**
  - **Smoking cessation if current smoker**

#8 Lung Cancer Screening

- Medicare and many private health insurance plans cover lung cancer screening without cost-sharing,
- Eligibility criteria varies based on type of plan the patient has
- **Benefit: Screening with LDCT has been shown to substantially reduce the risk of dying from lung cancer.**
- **Each year, more people die of lung cancer than of colon, breast, and prostate cancers combined.**
- In 2022,
  - **1,918,030 new cancer cases and**
  - **609,360 cancer deaths** are projected to occur in the United States, including approximately
  - **350 deaths per day from lung cancer** - the leading cause of cancer death (1 in 5).

American College of Radiology™

Lung-RADS® v2022

Release Date: November 2022

Lung-RADS	Category Descriptor	Findings	Management
0	**Incomplete** Estimated Population Prevalence: ~ 1%	Prior chest CT examination being located for comparison (see note 9)	Comparison to prior chest CT;
		Part or all oflungs cannot be evaluated	Additional lung cancer screening CT imaging needed;
		Findings suggestive of an inflammatory or infectious process (see note 10)	1-3 month LDCT
1	**Negative** Estimated Population Prevalence: 39%	**No lung nodules OR**	12-month screening LDCT
		Nodule with benign features: • Complete, central, popcorn, or concentric ring calcifications **OR** • Fat-containing	
2	**Benign -** Based on imaging features or indolent behavior Estimated Population Prevalence: 45%	**Juxtapleural nodule:** • < 10 mm (524 mm^3) mean diameter at baseline or new **AND** • Solid; smooth margins; and oval, lentiform, or triangular shape	
		Solid nodule: • < 6 mm (< 113 mm^3) at baseline **OR** • New < 4 mm (< 34 mm^3)	
		Part solid nodule: • < 6 mm total mean diameter (< 113 mm^3) at baseline	
		Non solid nodule (GGN): • < 30 mm (< 14,137 mm^3) at baseline, new, or growing **OR** • ≥ 30 mm (≥ 14,137 mm^3) stable or slowly growing (see note 7)	
		Airway nodule, subsegmental - at baseline, new, or stable (see note 11)	
		Category 3 lesion that is stable or decreased in size at 6-month follow-up CT **OR** Category 4B lesion proven to be benign in etiology following appropriate diagnostic workup	
3	**Probably Benign -** Based on imaging features or behavior Estimated Population Prevalence: 9%	**Solid nodule:** • ≥ 6 to < 8 mm (≥ 113 to < 268 mm^3) at baseline **OR** • New 4 mm to < 6 mm (34 to < 113 mm^3)	6-month LDCT
		Part solid nodule: • ≥ 6 mm total mean diameter (≥ 113 mm^3) with solid component < 6 mm (< 113 mm^3) at baseline **OR** • New < 6 mm total mean diameter (< 113 mm^3)	
		Non solid nodule (GGN): • ≥ 30 mm (≥ 14,137 mm^3) at baseline or new	
		Atypical pulmonary cyst: (see note 12) • Growing cystic component (mean diameter) of a thick-walled cyst	
		Category 4A lesion that is stable or decreased in size at 3-month follow-up CT (excluding airway nodules)	

INFECTION CATEGORY

Lung-RADS	Category Descriptor	Findings	Management
0	**Incomplete** Estimated Population Prevalence: ~ 1%	Prior chest CT examination being located for comparison (see note 9)	Comparison to prior chest CT;
		Part or all oflungs cannot be evaluated	Additional lung cancer screening CT imaging needed;
		Findings suggestive of an inflammatory or infectious process (see note 10)	**1-3 MONTH FOLLOWUP**

INFECTION CATEGORY DETAILS

- INFECTION SIGNS
  - NEW SEGMENTAL OR LOBAR CONSOLIDATION
  - MULTIPLE NEW NODULES (MORE THAN6)
  - LARGE NODULE (GREATER THAN 8 MM) APPEARING IN SHORT INTERVAL.
  - NEW NODULES IN IMMUNOCOMPRIMIZED
- AT 1-3 MONTH FOLLOW-UP A NEW LUNG-RADS CLASSIFICATION AND MANAGEMENT SHOULD BE PROVIDED BASED ON MOST SUSPICIOUS NODULE.

10. Suspected Infectious or Inflammatory Findings:

a. Lung-RADS 0 with 1-3 month follow-up LDCT may be recommended for pulmonary findings suggesting an indeterminate infectious or inflammatory process. Such findings may include segmental or lobar consolidation, multiple new nodules (more than six), large solid nodules (≥ 8 mm) appearing in a short interval, and new nodules in certain clinical contexts (e.g. immunocompromised patient). At 1-3 month follow-up, a new Lung-RADS classification and management recommendation should be provided based on the most suspicious nodule.

b. New solid or part solid nodules with imaging features more concerning for malignancy than an infectious or inflammatory process meeting Lung-RADS 4B size criteria may be classified as such with appropriate diagnostic and/or clinical evaluation.

c. Some findings indicative of an infectious or infectious process may not warrant short-term follow-up (e.g. tree-in-bud nodules or new < 3 cm ground glass nodules). These nodules may be evaluated using existing size criteria with a Lung-RADS classification and management recommendation based on the most suspicious finding.

4A	**Suspicious** Estimated Population Prevalence: 4%	**Solid nodule:** • ≥ 8 to < 15 mm (≥ 268 to < 1,767 mm^3) at baseline **OR** • Growing < 8 mm (< 268 mm^3) **OR** • New 6 to < 8 mm (113 to < 268 mm^3)	3-month LDCT; PET/CT may be considered if there is a ≥ 8 mm (≥ 268 mm^3) solid nodule or solid component
		Part solid nodule: • ≥ 6 mm total mean diameter (≥ 113 mm^3) with solid component ≥ 6 mm to < 8 mm (≥ 113 to < 268 mm^3) at baseline **OR** • New or growing < 4 mm (< 34 mm^3) solid component	
		Airway nodule, segmental or more proximal - at baseline (see note 11)	
		Atypical pulmonary cyst: (see note 12) • Thick-walled cyst **OR** • Multilocular cyst at baseline **OR** • Thin- or thick-walled cyst that becomes multilocular	
4B	**Very Suspicious** Estimated Population Prevalence: 2%	**Airway nodule,** segmental or more proximal - stable or growing (see note 11)	Referral for further clinical evaluation
		Solid nodule: • ≥ 15 mm (≥ 1767 mm^3) at baseline **OR** • New or growing ≥ 8 mm (≥ 268 mm^3)	Diagnostic chest CT with or without contrast; PET/CT may be considered if there is a ≥ 8 mm (≥ 268 mm^3) solid nodule or solid component; tissue sampling; and/or referral for further clinical evaluation Management depends on clinical evaluation, patient preference, and the probability of malignancy (see note 13)
		Part solid nodule: • Solid component ≥ 8 mm (≥ 268 mm^3) at baseline **OR** • New or growing ≥ 4 mm (≥ 34 mm^3) solid component	
		Atypical pulmonary cyst: (see note 12) • Thick-walled cyst with growing wall thickness/nodularity **OR** • Growing multilocular cyst (mean diameter) **OR** • Multilocular cyst with increased loculation or new/increased opacity (nodular, ground glass, or consolidation)	
		Slow growing solid or part solid nodule that demonstrates growth over multiple screening exams (see note 8)	
4X	Estimated Population Prevalence: < 1%	Category 3 or 4 nodules with additional features or imaging findings that increase suspicion for lung cancer (see note 14)	
S	**Significant or Potentially Significant** Estimated Population Prevalence: 10%	**Modifier:** May add to category 0-4 for clinically significant or potentially clinically significant findings unrelated to lung cancer (see note 15)	As appropriate to the specific finding

S MODIFIER – OTHER SIGNIFICANT FINDINDS

S	**Significant or Potentially Significant** Estimated Population Prevalence: 10%	**Modifier:** May add to category 0-4 for clinically significant or potentially clinically significant findings unrelated to lung cancer (see note 15)	As appropriate to the specific finding

NEW GUIDELINES IN NOV 2022

How does the new guideline differ from the previously published guideline?

Item	Previous Recommendations	New Recommendations
Age for eligibility	55-74 years	50-80 years
Pack-year (PY) history	30+ PY	20+ PY
Years since quitting (YSQ)	≤ 15 YSQ	No Longer Required

#8 INCIDENTAL LUNG NODULES

FLESCHNER CRITERIA

Pulmonary Nodule Size	Lung Nodule Type	Single vs. Multiple	Low Risk Patient	High Risk Patient
< 6mm (< 100mm^3)	Solid	Solitary	No Follow-Up If suspicious morphology or upper lobe location, consider 12-month follow-up.	Optional CT in 12 months
		Multiple	No Follow-Up If suspicious morphology or upper lobe location, consider 12-month follow-up.	Optional CT in 12 months
	Part-Solid (Subsolid)	Solitary	No Follow-Up	
		Multiple	CT in 3 to 6 months. If unchanged, consider CT at 2 and 4 years.	
	Ground-Glass	Solitary	No Follow-Up If suspicious, consider follow-up at 2 and 4 years. If grows or increasingly solid, consider resection.	
		Multiple	CT in 3 to 6 months. If unchanged, consider CT in 2 and 4 years.	

Pulmonary Nodule Size	Lung Nodule Type	Single vs. Multiple	Low Risk Patient	High Risk Patient
< 6mm	Solid	Solitary	No Follow-Up If suspicious morphology or upper lobe location, consider 12-month follow-up.	Optional CT in 12 months
		Multiple	No Follow-Up If suspicious morphology or upper lobe location, consider 12-month follow-up.	Optional CT in 12 months

	Ground-Glass	Solitary	CT in 6 to 12 months to confirm persistence, then CT every 2 years until 5 years. If grows or increasingly solid, consider resection.	
		Multiple	CT at 3 to 6 months. Then management based on most suspicious nodule(s).	

FOR INCIDENTAL LUNG NODULES

NOT VALID FOR SCREENING LDCT

NOT FOR PATIENTS WITH LUNG CANCER

FOR PATIENTS OLDER THAN 35

IMAGES FROM RADIOLOGY ASSISTANT WEBSITE

Risk factors

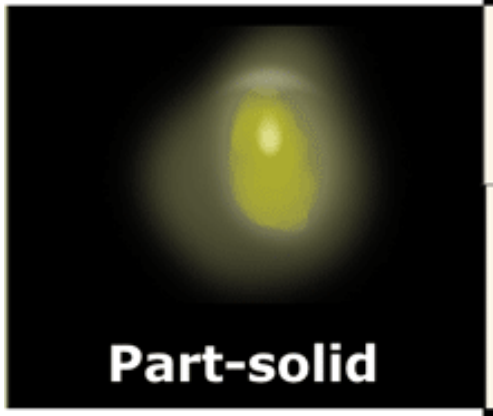
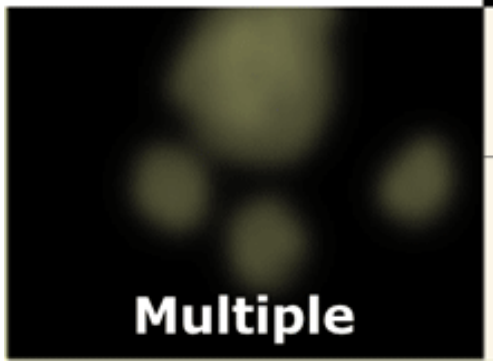
- History of heavy smoking
- Exposure to asbestos, radon or uranium
- Family history of lung cancer
- Older age
- Sex (Females > Males)
- Race (Black and native Hawaiian > White)
- Marginal spiculation
- Upper lobe location
- Multiplicity (<5 nodules increases risk for malignancy)
- Emphysema and pulmonary fibrosis (particularly IPF)

SOLID NODULES

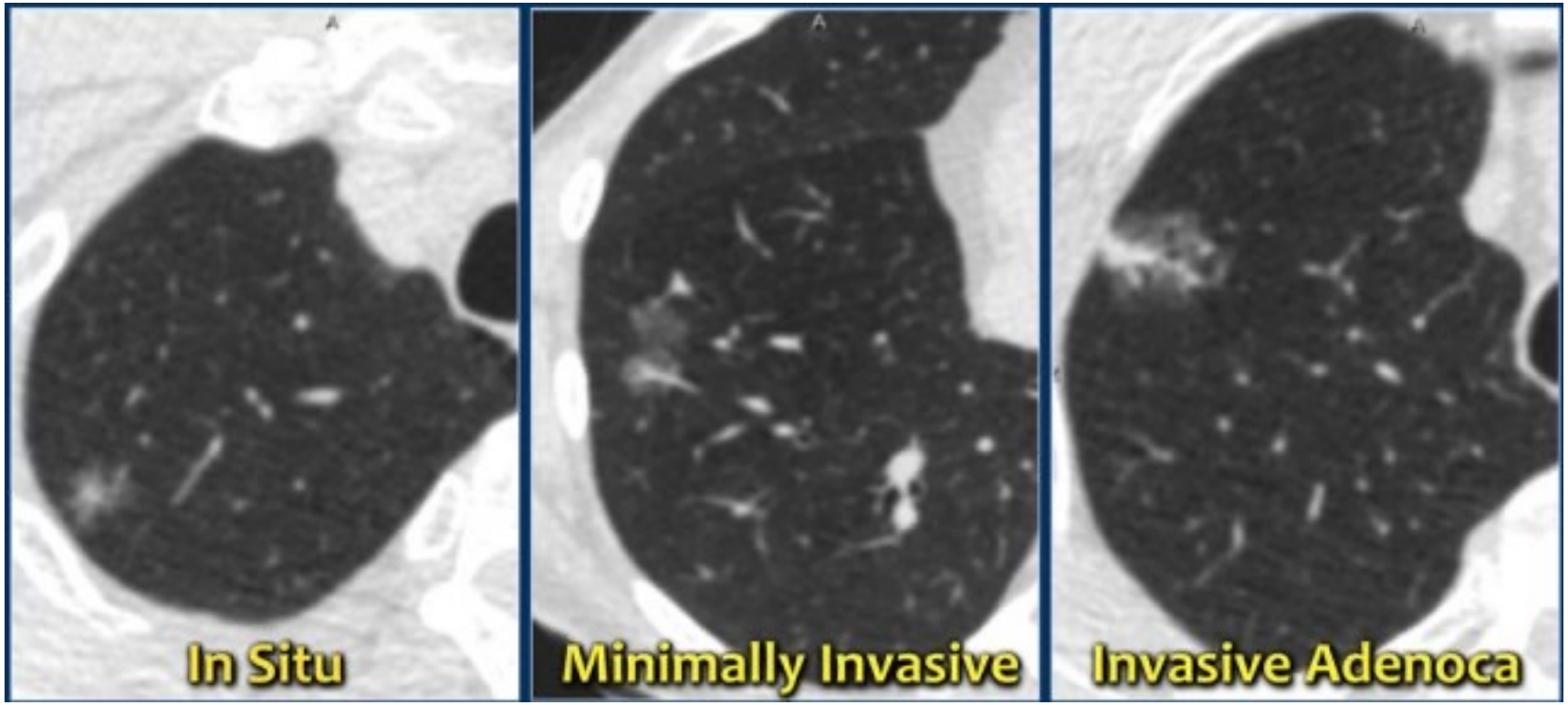
- Solid pulmonary nodules can represent various etiologies:
  - •benign granulomas – USUALLY CALCIFIED
  - •focal scar
  - •intrapulmonary lymph nodes USUALLY PERIFISSORAL - Benign
  - •primary malignancies
  - •metastatic disease.
- Professorial nodules are a separate entity,
  - Usually represent intrapulmonary lymph nodes, which are benign and need no follow up.

FROM RADIOLOGY ASSISTANT

Most subsolid nodules are transient and the result of infection or hemorrhage. However, persistent subsolid nodules often represent pathology in the adenocarcinomatous spectrum.

Subsolid	Size	Follow up
 Groundglass	< 6 mm	No FU indicated
	≥ 6 mm	CT at 6-12 months to confirm persistence, then CT at 3 and 5 years
 Part-solid	< 6 mm	No FU indicated
	≥ 6 mm	CT at 3-6 months to confirm persistence, then annual CT for 5 years
 Multiple	< 6 mm	CT at 3-6 months. If stable CT at 2 and 4 years
	≥ 6 mm	CT at 3-6 months. Subsequent management based on most suspicious nodule

Compared to solid lesions, persistent subsolid nodules have a much slower growth rate, but carry a much higher risk of malignancy.


In Situ
Minimally Invasive
Invasive Adenoca

FLEISHNER CRITERIA

- **DOES NOT** apply to:
  - Patients who have a known cancer.
  - Immunosuppressed patients.
  - Lung cancer screening, which has separate criteria.
  - Intra-fissural, peri-fissural, and subpleural pulmonary nodules. Perifissural lung nodules are usually benign,

Notes using 2017 Fleischner guideline for pulmonary nodule management

- Only apply in subjects 35 years or older
- Do not apply in immunocompromised subjects, or patients with a known or suspected malignancy
- Use thin-slice (low-dose) CT imaging with off-axis reconstructions to characterize and follow-up lung nodules
- Manual nodule measurements should be based on the average of long- and short-axis diameters (obtained on the same image in any plane). Alternatively, use nodule volumetry. In case of using (semi-automated) nodule volumetry, keep imaging technique and software constant during follow-up
- The new guideline requires risk-stratification on both patient- and nodule-characteristics, contrarily to the old document that only stratified low- or high-risk subjects

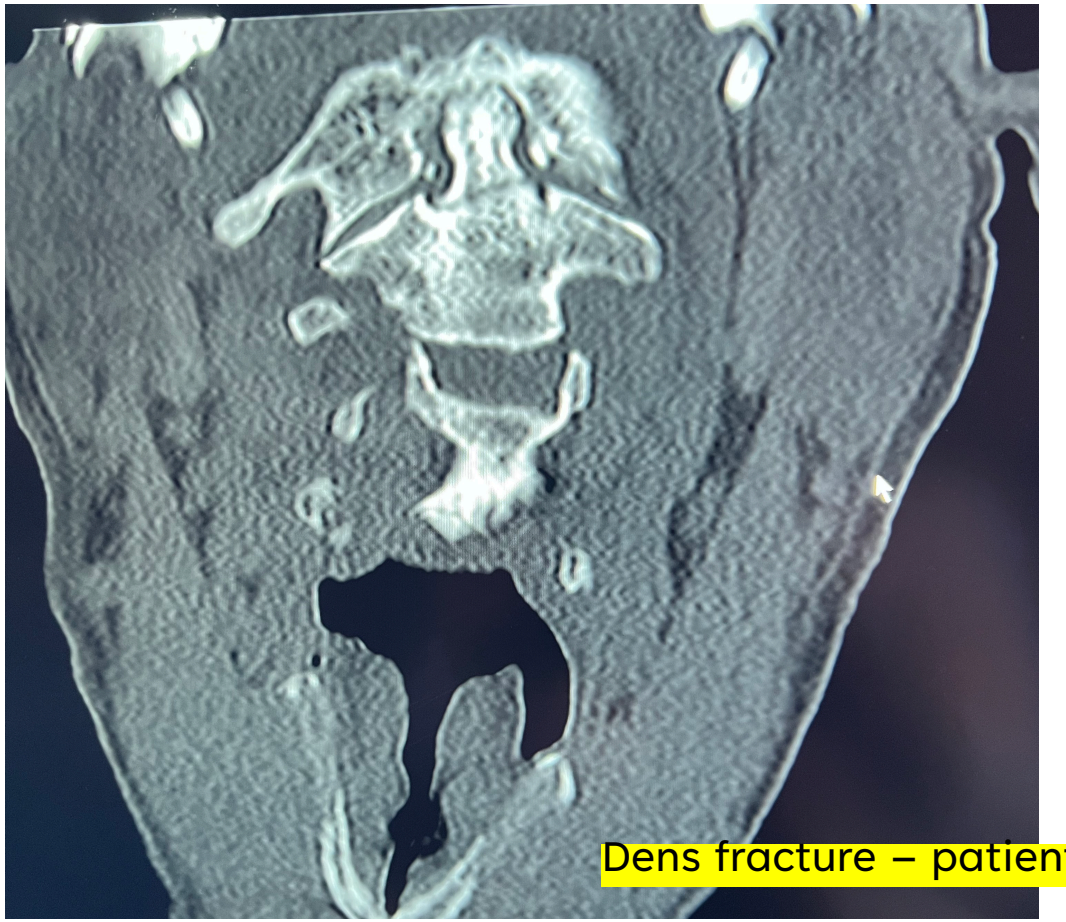
#9 PEARLS

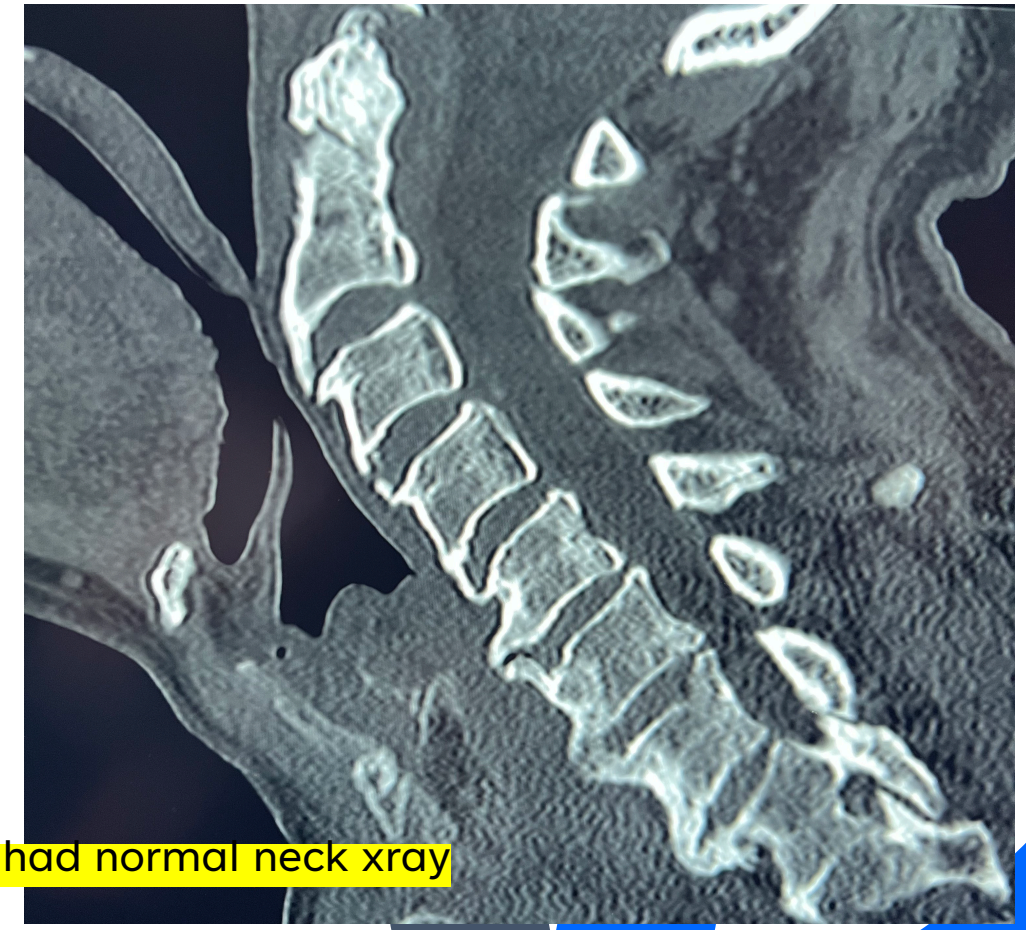
PEARLS

- If you need to see a body part – order that body part.
  - Don’t say things like:
    - CT of the chest please include liver – order CT chest and CT abdomen
- Don’t tell the radiologist how to do/read exam in most cases:
  - No need for oral
  - Please use oral
  - Please look at kidney
    - Regardless of what you order, we look at everything

9-1 Pearls

1. Patient status post trauma with neck pain – equals a CT. An x-ray just not sensitive enough.





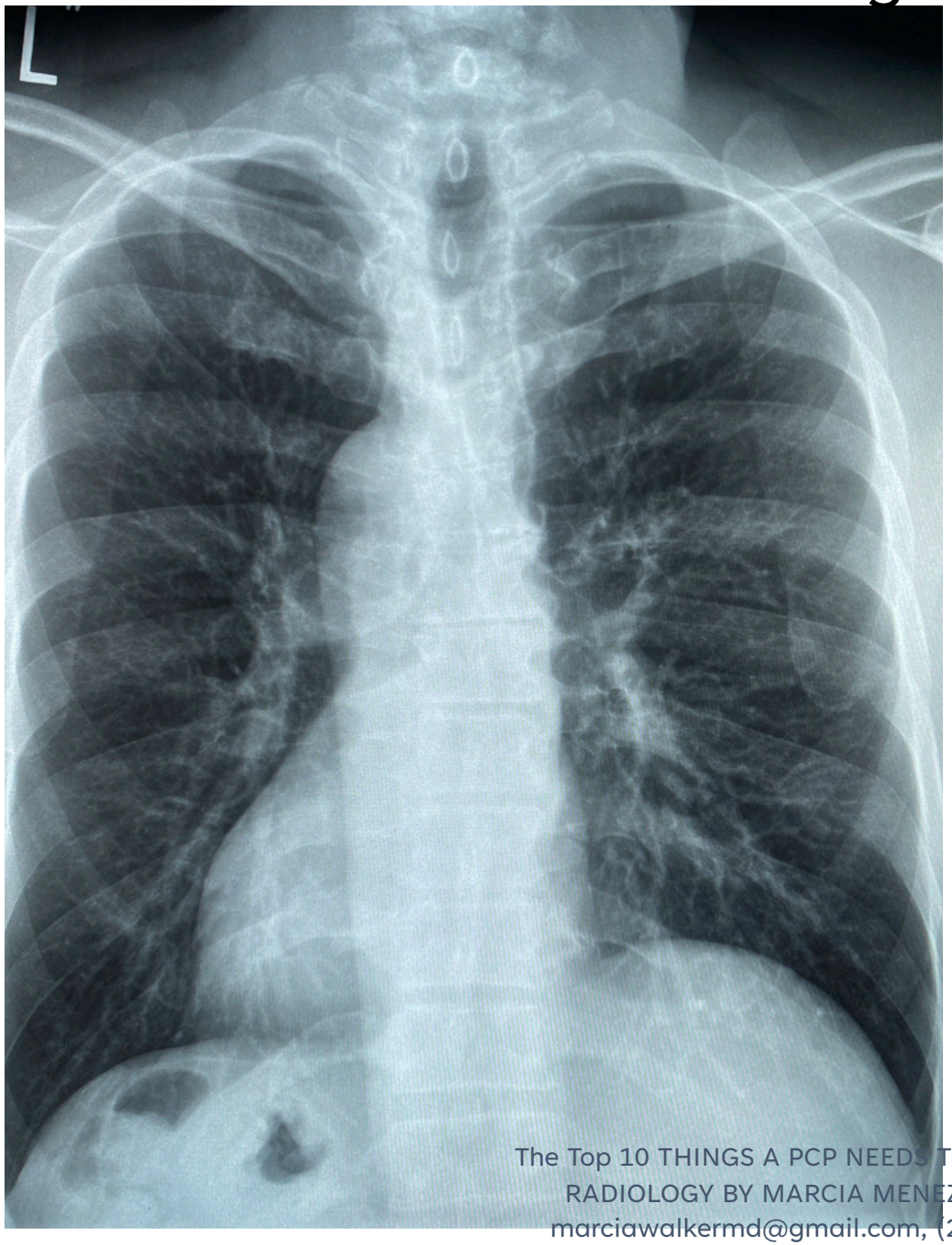
Dens fracture – patient had normal neck xray

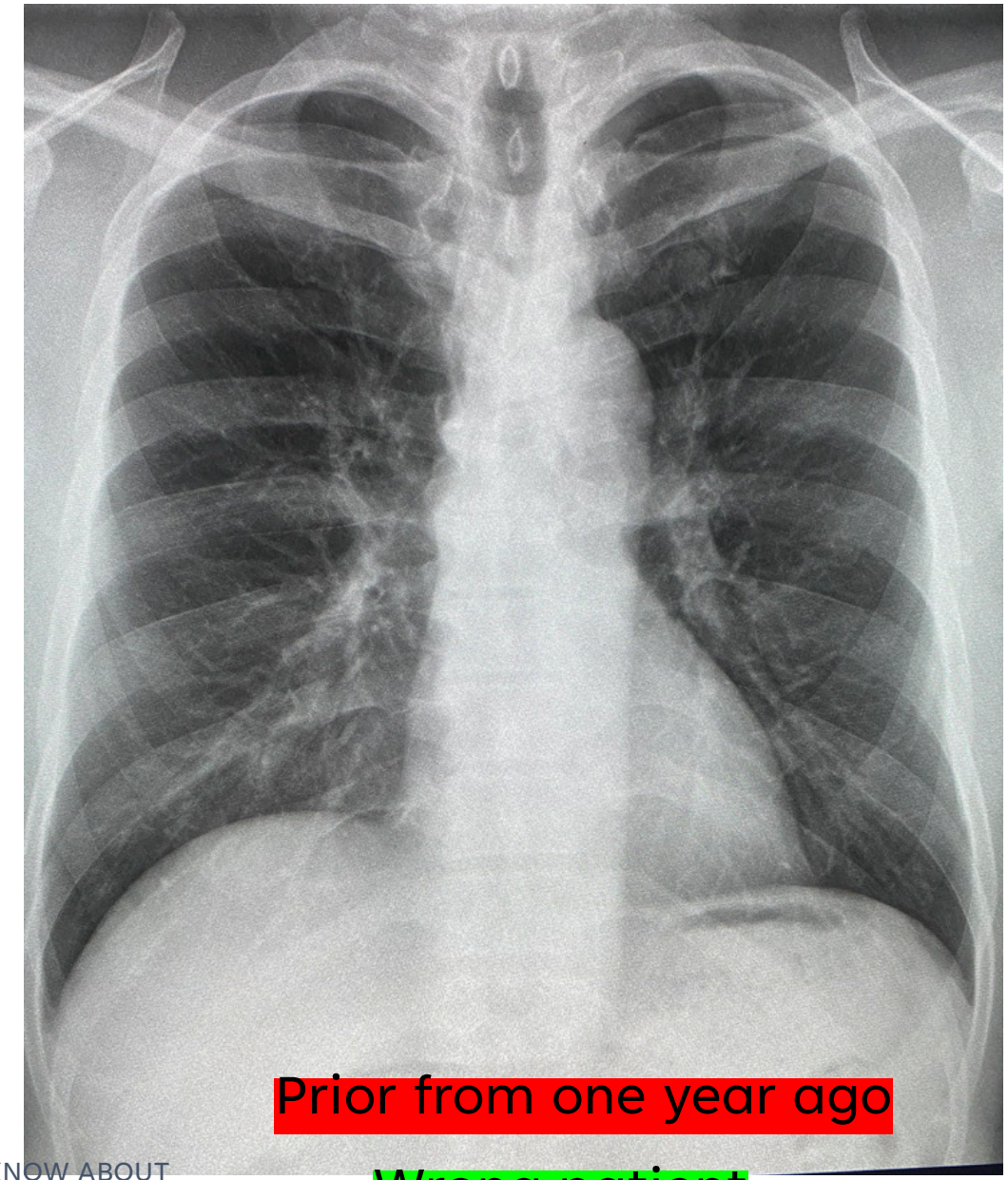
9-2 Pearls – Make sure the images are for the correct patient

1st year case

Stop

50 yo
Routine
Physical





Prior from one year ago

Wrong patient

9-3 Pearls – Fake versus real fractures

Fake fracture

Case – 2 year

45 yo with trauma & pain

9 Pearls – More Pearls

- If you order a CT A/P:
  - No need to order abdominal US unless recommended by rad (sometimes for acute cholecystitis).
  - No need to order KUB
  - No need to order US to evaluate for AAA
    - Aorta size – 3 cm for abdominal
- Why are measurements different on different studies
  - CT better than US
  - Measurement technique
- A high resolution CT is not a better CT than a regular CT of chest
  - It is just done differently

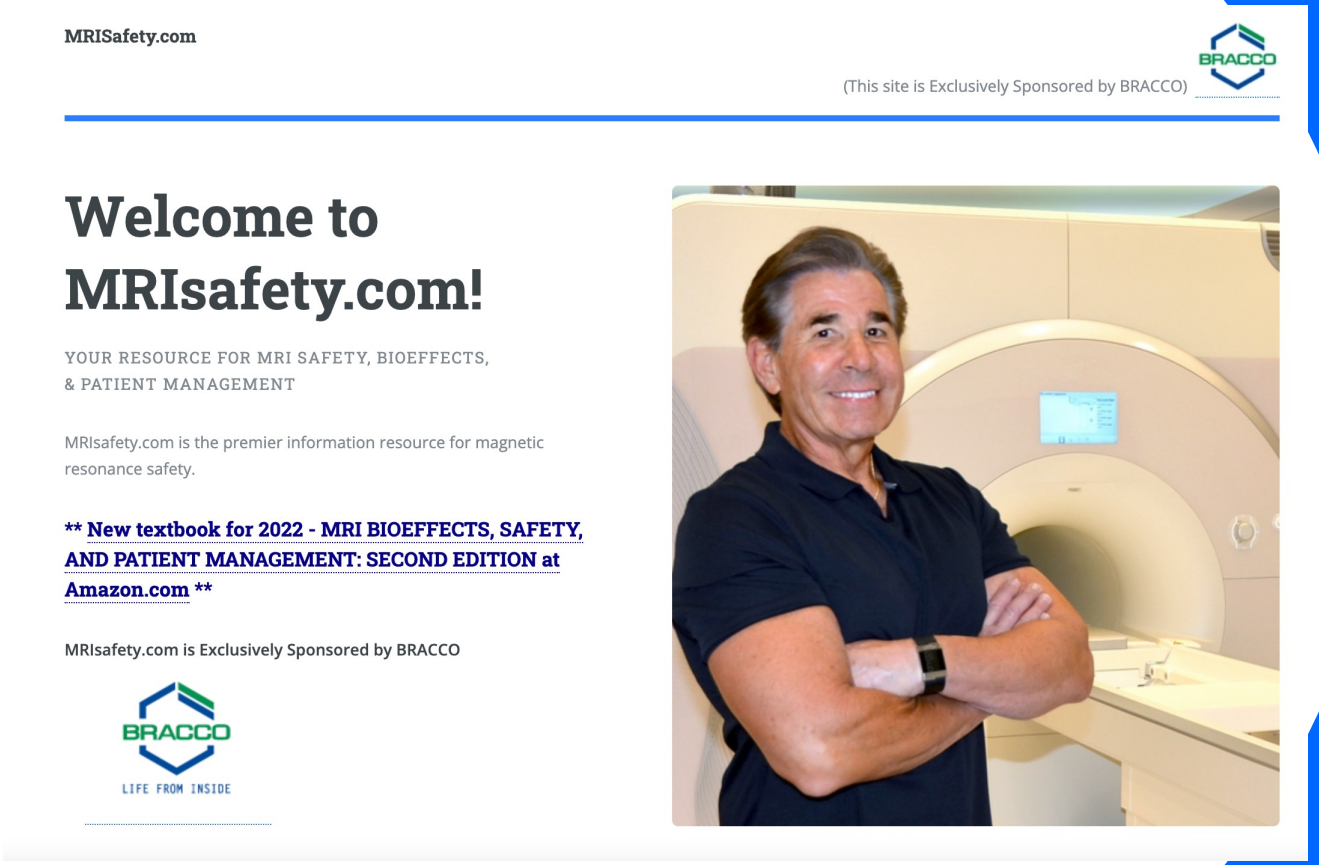
#10 MRI

#10 MRI

- Not the best modality for everything
  - Wonderful for characterizations of masses
  - Finding an acute stroke
  - MSK abnormalities
- Don’t start work up for abdominal pain with MRI
  - MRI is done of abdomen or pelvis – not both like CT
  - MRI has better superb contrast resolution - but CT had better special resolution
- Look at the easy absolute contra-indications

#10 MRI

- Contra-indications
  - Most pace makers
    - Newers are compatible – a lot of steps to get it done
  - Spine stimulators
  - Shrapnel near vital structures
  - Cochlea implants
  - Some tatus
- When in doubt – search MRIsafety or call MRI tech or rad
- No contra-indications
  - Joint replacements - unless immediate post op
  - ORIF hardware



#10 MRI

- When you have a choice between CT or MRI
  - Examples: Adrenal gland lesions, most renal and liver lesions
  - Take into account that some patients cannot stay still for MRI
    - CT is easier because it is so quick.
    - Quicker to get patient in the schedule

MRI

- Never order an MRI for general abdominal pain. MRI is usually for solving a problem no solved by CT.
  - MRI is done usually for either abdomen or the pelvis, not both

#10 MRI

- Contrast Reactions
  - Serious adverse reactions are significantly less common than those caused by the iodinated agents used in CT scans
- NSF – Nephrogenic Systemic fibrosis
  - Rare - Seen in past two decades – peaked at 500 in 2010. As of 2013, a cumulative 1603 cases of NSF had been reported
  - Fibrosing disorder with a poor prognosis, characterized by skin and subcutaneous thickening as well as systemic manifestations
  - Disease onset has been reported to occur on the same day as the GBCA exposure and up to 1 year afterward
    - However, delayed onset of disease of up to 10 years after GBCA exposure has been reported.

#10 MRI

- Related to exposure to Group I gadolinium-containing MRI contrast agents exclusively in patient with end-stage renal disease.
- ACR divides gadolinium-based contrast into 3 groups reflecting their associated risk of NSF:
  - Group I: highest risk;
  - Group II: very low risk;
  - Group III: likely very low risk but limited data available

#10 MRI

Group II agents are associated with few unconfounded cases of NSF.

Generic Name	Trade Name	EMA*	FDA†	AC
Gadodiamide	Omniscan®	High	+	Grou
Gadoversetamide	OptiMark®	High	+	Grou
Gadopentetate dimeglumine	Magnevist®	High	+	Grou
Gadobenate dimeglumine	MultiHance®	Intermed	–	Grou
Gadoteridol	ProHance®	Low	–	Grou
Gadobutrol	Gadavist®	Low	–	Grou
Gadoteric acid	Dotarem®	Low	NA	Grou
Gadoxetic acid	Eovist®/Primovist®	Intermed	–	Grou
~~Gadofosveset~~	~~Ablavar®~~	~~Intermed~~	~~–~~	~~Grou~~

Discontinued

In 2009, the FDA determined that moderate renal impairment (eGFR 30-60 mL/min/1.73 m^2) was NOT a risk factor for NSF.

*NSF risk
†Contraindicated in patients with AKI or severe CKD (GFR <30 mL/min/1.73 m^2)
‡Associated with NSF

#10 MRI SUMMARY

1

WHEN TO ORDER

NOT THE BEST FOR EVERYTHING

RARELY THE FIRST EXAM TO ORDER

2

LOOK AT CONTRA-INDICATIONS

PACE MAKERS

MRISAFETY.COM

3

ALLERGY

ALLERGY TO CT CONTRAST DOES NOT MEAN ALLERGY TO MRI CONTRAST

4

LOW GFR CONCERN

CONCERN FOR NEPHROGENIC SYSTEMIC FIBROSIS

5

CONTRAST OR NO CONTRAST

DEPENDS ON INDICATION.

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   - Kyongtae T. Bae, RSNA, July 1 2010
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Thank you

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