XRAY/ IMAGING MISSES

"DODGING THE SHADOWS"

NDAFP BIG SKY MEETING 2026

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OBJECTIVES

1. Discuss the role of imaging in the workup of **common complaints**.
2. Describe the benefits and limitations of multiple **imaging modalities** including incidentalomas.
3. Discuss the benefit of using **appropriateness criteria** in the selection of imaging exams

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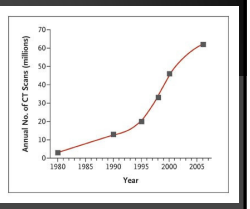
THE PROMISE OF IMAGING

- What's inside?
- Marie Curie (1867-1934)
  - Polonium and Radium
- Wilhelm Conrad Röentgen
- (1895 accidental discovery)
- Now 3-Dimensional Imaging
- 1970s CT scan, by 1980 3m CT in U.S.
- By '07 62 m/year in US (4m children)
- ½ of body, 1/3 Head, 75% in hospital



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STAR TREK AND THE TRIQUARTER

Simple test to ascertain what is going on inside

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CLINICAL SCENARIOS

- Febrile patient with a productive cough of 7 days with dyspnea
- 57 yo F with RUQ post-prandial pain
- 45 M with 1 week of LBP after lifting injury
- 85 yo F with fall and R hip pain unable to bear weight and shortened internally rotated leg
- 66 yo F with CT abdomen showing small liver cysts and one renal cyst and pelvic calcifications

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CLINICAL SCENARIOS

- Febrile patient with a productive cough of 7 days with dyspnea: CXR
- 57 yo F with RUQ post-prandial pain: GB U/S
- 45 M with 1 week of LBP after lifting injury: No Imaging
- 85 yo F with fall and R hip pain unable to bear weight and shortened internally rotated leg: Bilateral Hip Xray (perhaps just AP)
- 66 yo F with CT abdomen showing small liver cysts and one renal cyst and pelvic calcifications: No further imaging necessary

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SOME MISSES ARE …….FROM IMAGING WHICH SHOULD NOT HAVE BEEN ORDERED

- Finding self-limited problems
- Finding abnormalities not related to the presenting problem
- Putting insufficient information on ordering requisition
- With non-specific indications, the radiologist often responds with very general read and suggestions of further imaging modalities to answer possible questions

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AMERICAN COLLEGE OF RADIOLOGY ACR: APPROPRIATENESS CRITERIA

- 22 expert panels, with one or two for each specific anatomical area of interest
- Panelists assign a score
- Ratings of 1-3 indicate a test is not usually appropriate; ratings of 4-6 mean a test may or may not be appropriate; and ratings of 7-9 mean a test is usually appropriate
- RRL of from 0 to 5 radiation symbols (☢) is applied

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ACUTE LBP WITH OR WITHOUT RADICULOPATHY: NO IMAGING

Variant 1: **Acute low back pain with or without radiculopathy. No red flags. No prior management. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography lumbar spine	Usually Not Appropriate	☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
MRI lumbar spine without and with IV contrast	Usually Not Appropriate	O
MRI lumbar spine without IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
CT lumbar spine without IV contrast	Usually Not Appropriate	☢☢☢
Discography and post-discography CT lumbar spine	Usually Not Appropriate	☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography lumbar spine	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

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LBP WITH OR WITHOUT RADICULOPATHY > 6 WEEKS OF OPTIMAL MED MGMT.

Variant 3: **Subacute or chronic low back pain with or without radiculopathy. Surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks of optimal medical management. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI lumbar spine without IV contrast	Usually Appropriate	O
Radiography lumbar spine	May Be Appropriate	☢☢☢
MRI lumbar spine without and with IV contrast	May Be Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	May Be Appropriate	☢☢☢
CT lumbar spine without IV contrast	May Be Appropriate	☢☢☢
CT myelography lumbar spine	May Be Appropriate	☢☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
Discography and post-discography CT lumbar spine	Usually Not Appropriate	☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

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COMMON PRIMARY CARE DIAGNOSES

- **Essential Hypertension**: I10
- **DMII without Complications**: E11.9
- **Hyperlipidemia**: E78.5 (or other E78.2)
- **Low Back Pain**: M54.50 ********
- **COPD**: J44.9 *****
- **Atrial Fibrillation**: Paroxysmal (I48.0), Persistent (I48.1) Chronic (I48.2) Unspecified (I48.91)
- **Abdominal Pain**: R10.9
- **CAD**: Atherosclerotic heart disease of native coronary artery without angina pectoris: I25.10. *********
- **UTI**: N39.0
- **Anxiety**: F49.0
- **Major Depressive Disorder**, Single Episode, mild: F32.0 (moderate F32.1) Recurrent Moderate (F33.1)
- **GERD**: K21.9
- **Limb Pain**: M79.609. **Chest Pain**: R07.9. ******
- **Other Malaise & Fatigue**: Neoplasm related fatigue: R53.0, Weakness R53.1, Other Malaise R53.81, Other Fatigue R53.83 Post Viral Fatigue G93.3
- **Acute Upper Respiratory Infection**: J06.9 other specified diseases of the upper respiratory tract J98.8
- **Pneumonia** J18.9 ********
- **Acute Bronchitis**: (J20.9). ********
- **Specific Etiologies**: Parainfluenza virus (J20.4) RSV(J20.5), Rhinovirus (J20.8), etc
- **Pain in Joint Lower Leg**: M25.561 or Osteoarthritis Knees (M17.0)
- **Heart Failure**: I50.9 Acute Systolic (I50.21), Chronic Systolic (I50.22), Acute on Chronic (I50.23), Acute Diastolic Combined Chronic (I50.4), End-Stage (I50.84) **********
- **Hypothyroidism**: E03.9

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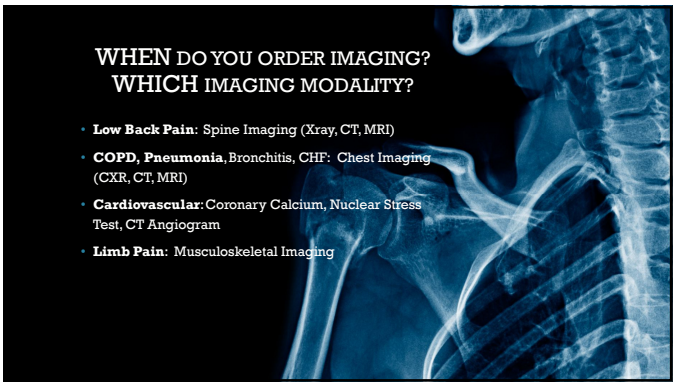
WHEN DO YOU ORDER IMAGING? WHICH IMAGING MODALITY?



- **Low Back Pain**: Spine Imaging (Xray, CT, MRI)
- **COPD, Pneumonia**, Bronchitis, CHF: Chest Imaging (CXR, CT, MRI)
- **Cardiovascular**: Coronary Calcium, Nuclear Stress Test, CT Angiogram
- **Limb Pain**: Musculoskeletal Imaging

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CHEST: CXR IMAGE QUALITY

- Position (PA)
- Penetration: Should see thoracic vertebrae
- Inspiration
- Rotation
- Magnification
- Angulation

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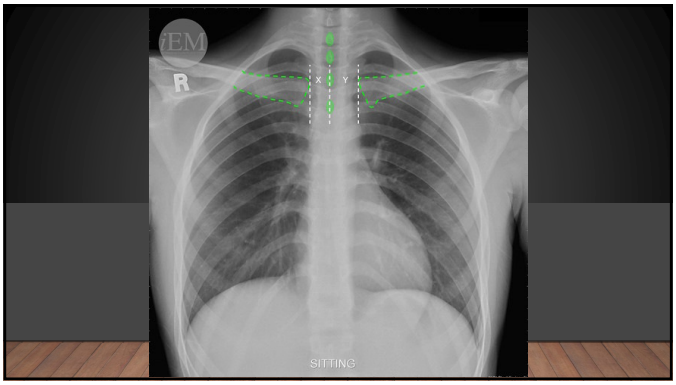

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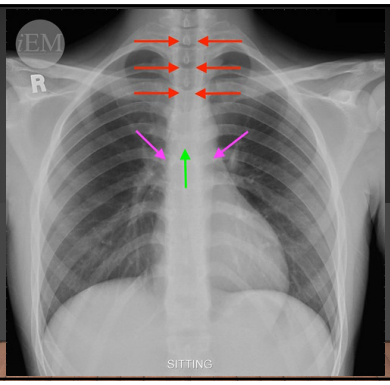
Airway
Red: Trachea
Green: Carina
Pink: L & R bronchus



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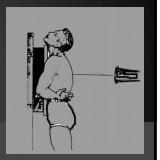
POSITION

- Posteroanterior (PA)
  - Erect inspiratory posteroanterior is the preferred CXR view
  - Patient stands in front of a radiographic plate, hands on hips
  - The X-ray source 2 m behind.
- Lateral
  - Left lateral CXR is performed with the patient standing. It is used in combination with a PA CXR to further delineate and localize masses, lesions or consolidation, particularly those obscured by the heart or diaphragms



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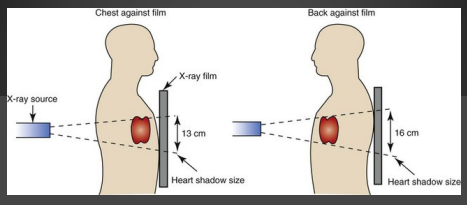
PA VERSUS AP: HEART MAGNIFICATION



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PENETRATION

- Exposure should be adequate if you are able to see approximately T4 vertebra and spinal process
- Overexposure is where you are able to see all vertebral bodies with obvious intervertebral spaces
- An optimally exposed chest radiograph, the lung parenchyma is displayed at a mid-gray level
- Slightly visible lower intervertebral disc below T9
- (Emphysema lungs are hyperinflated and diaphragm flattened)
- Pneumothorax has pleural white line

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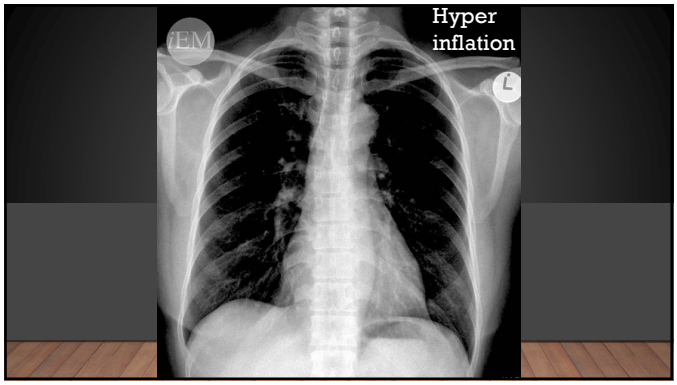

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INSPIRATION:

- Ideally at the end of a deep breath
- Diaphragm at it's lowest
- 8th – 10th posterior rib or 5th – 6th anterior rib

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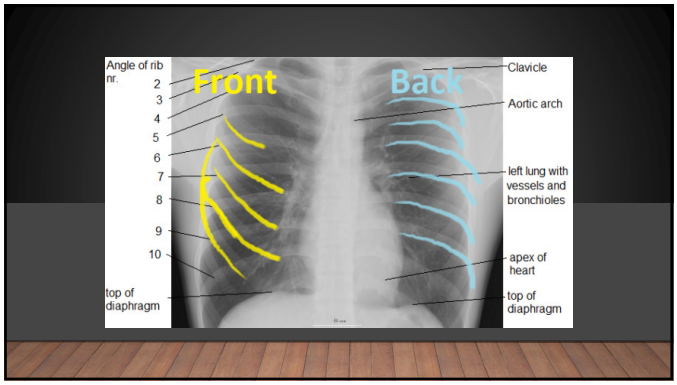

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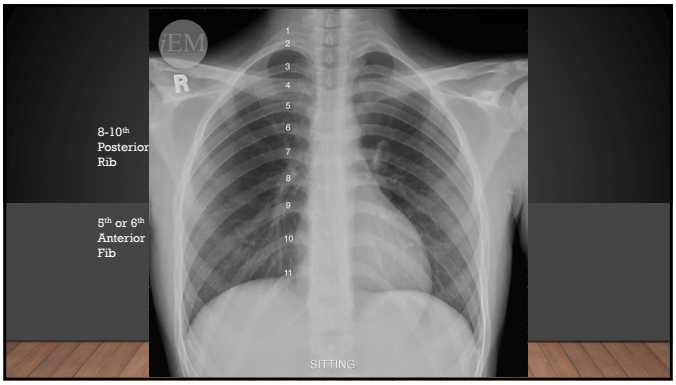

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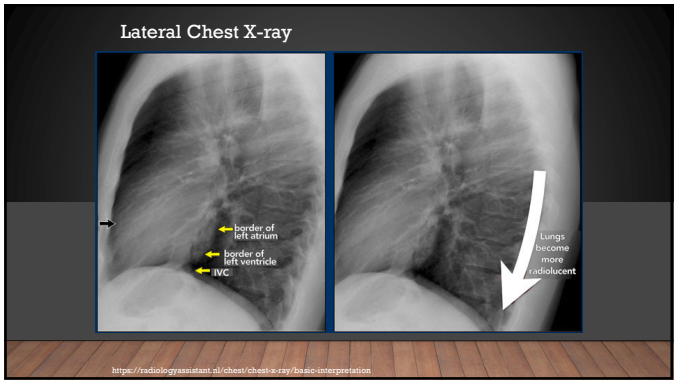

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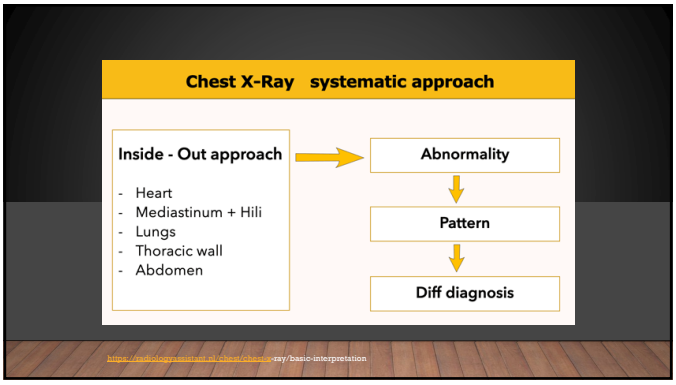

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COMPARE NEW AND OLD FILMS

Once you compare the chest film to the old one, things become more obvious, and you will be much more confident in your diagnosis of congestive heart failure:

1. The size of the heart is slightly increased compared to the old film but was already large on the old film.
2. The pulmonary vessels are slightly increased in diameter indicating increased pulmonary pressure.
3. There are maybe some subtle interstitial markings as a result of interstitial edema.
4. There is pleural fluid bilaterally. Notice that the infero-posterior border of the lower lobes has changed in position.

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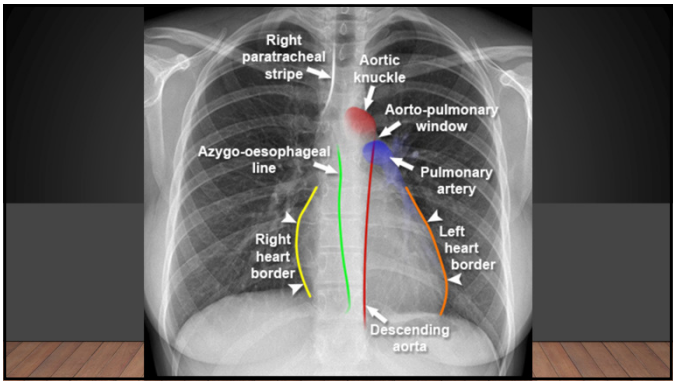

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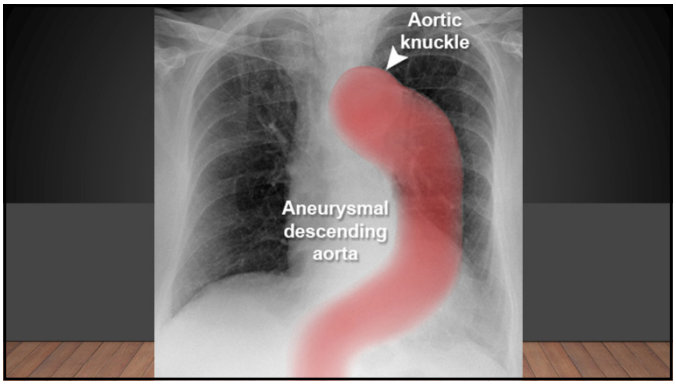

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PNEUMONIA & SILHOUETTE SIGN

- Silhouette of the heart borders; the ascending and descending aorta; the aortic knuckle and the hemidiaphragms should be clearly visible.
- All of these silhouettes, or structures, are in contact with a specific portion of the lung.
- Obliteration of any of these silhouettes by a water density e.g., infection in the lung, blood, pus, etc.
- Obliteration of this normal air-soft tissue interface is known as the silhouette sign (of Felson).
- By determining exactly **which silhouette**/structure is obliterated, you can determine **where** the lung pathology is located.

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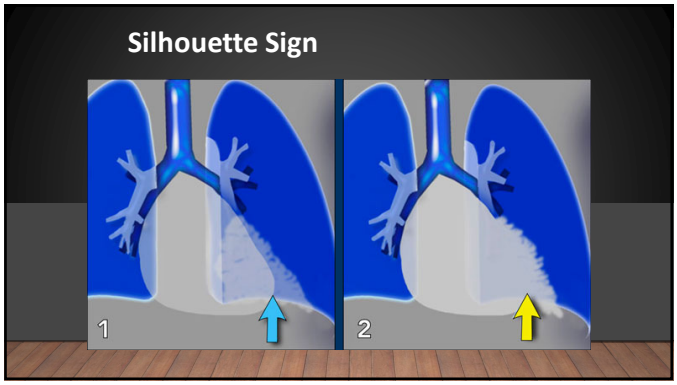

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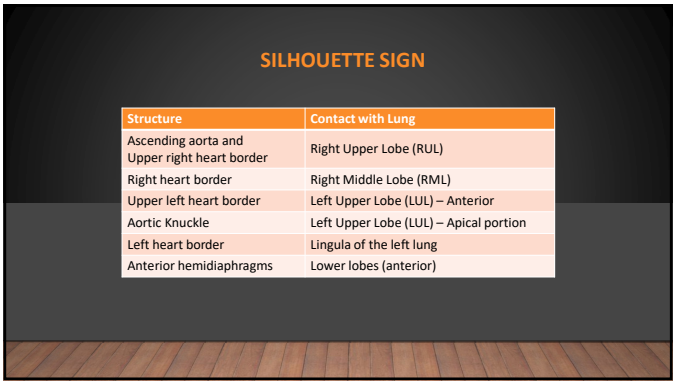

Structure	Contact with Lung
Ascending aorta and Upper right heart border	Right Upper Lobe (RUL)
Right heart border	Right Middle Lobe (RML)
Upper left heart border	Left Upper Lobe (LUL) – Anterior
Aortic Knuckle	Left Upper Lobe (LUL) – Apical portion
Left heart border	Lingula of the left lung
Anterior hemidiaphragms	Lower lobes (anterior)

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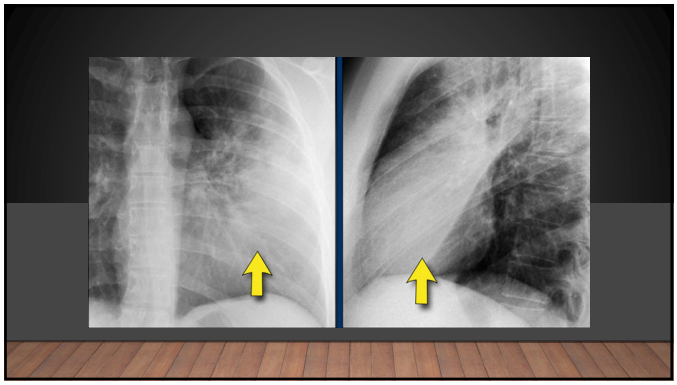

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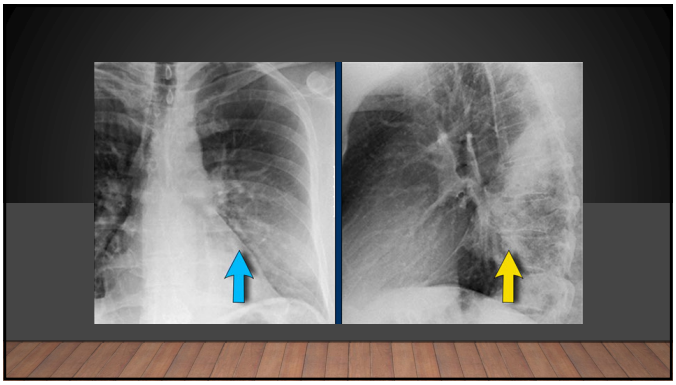

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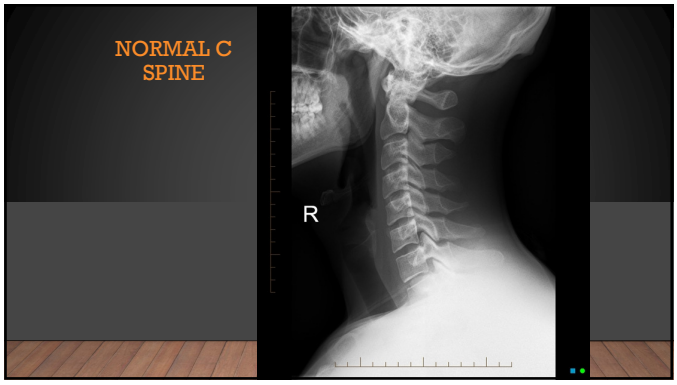

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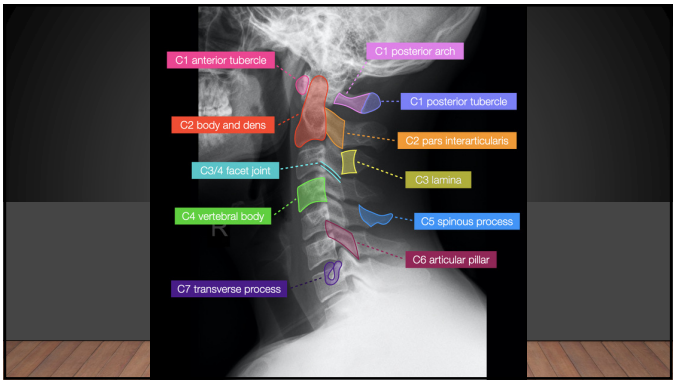

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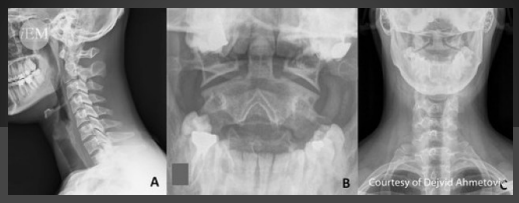
CERVICAL SCREENING



Lateral view with normal slight lordosis (A),
Odontoid or open mouth view of the atlas and axis (B),
Standard anteroposterior or AP view with open mouth, it can also be taken with closed mouth (C).

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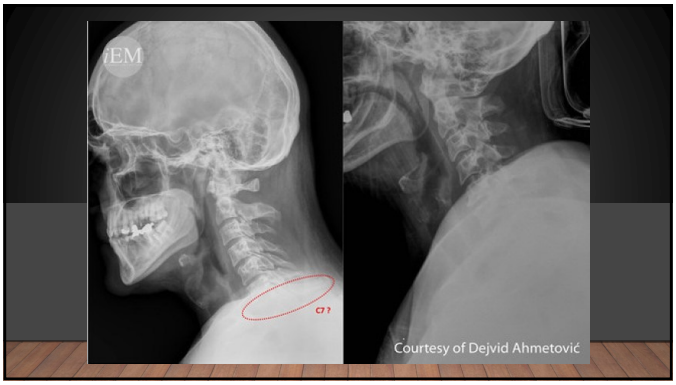

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CROSS TABLE

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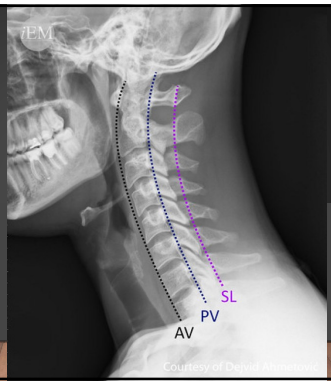
AV) ANTERIOR VERTEBRAL
(PV) POSTERIOR VERTEBRAL
(SL) SPINOLAMINAR LINES

SHOULD RUN SMOOTH, WITHOUT ANY DISRUPTIONS
SHOULD FORM A SLIGHT LORDOTIC SHAPE



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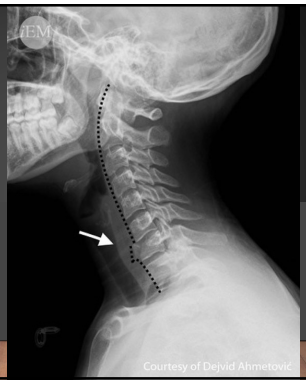
DISRUPTION IN THE SHAPE OF THE AV LINE, THAT INDICATES INJURY, AND IN THIS CASE A FRACTURE OF THE BODY OF C7



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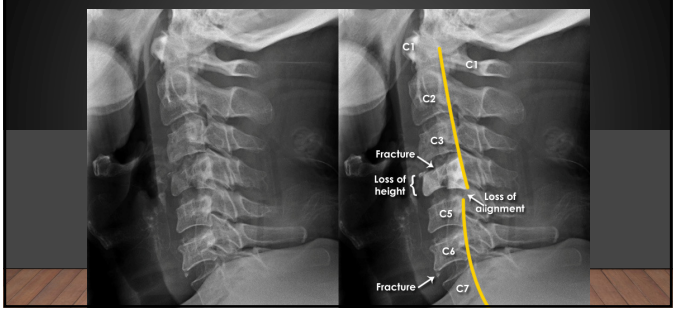
C-4 FRACTURE



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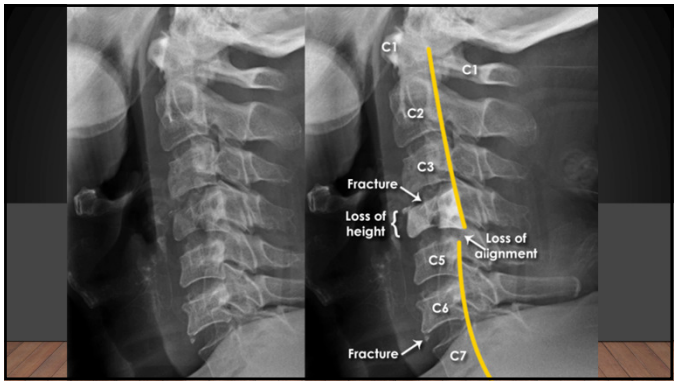

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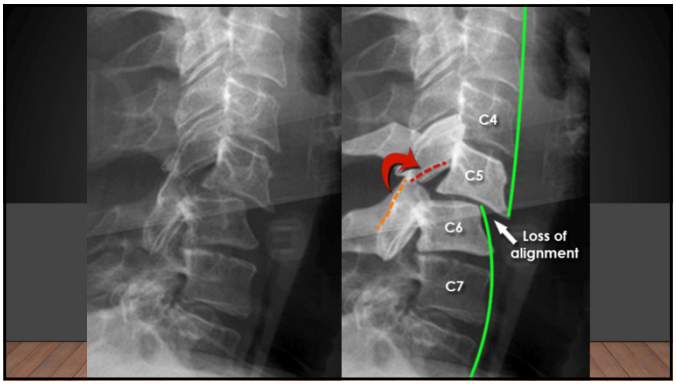

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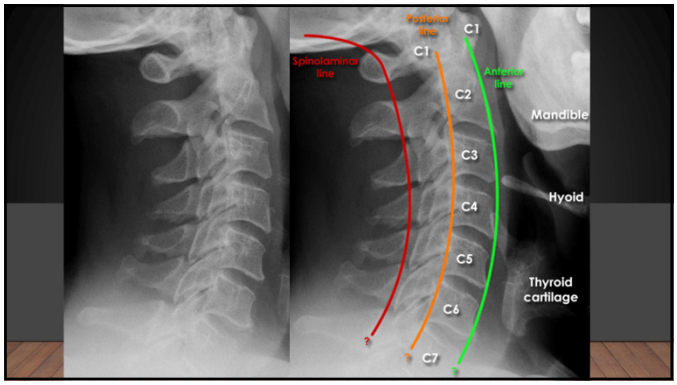

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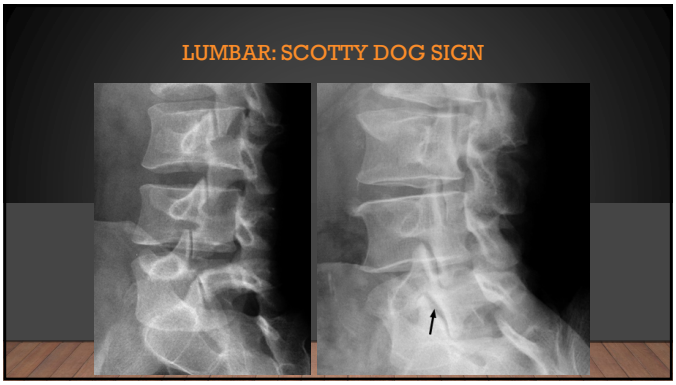

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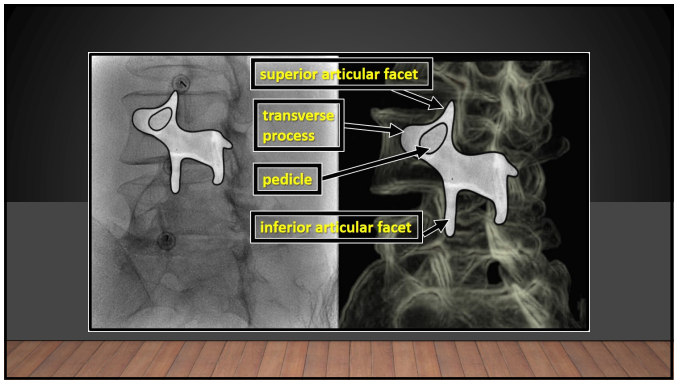

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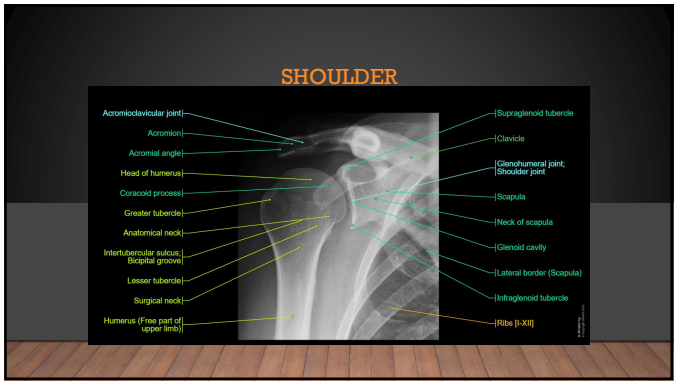

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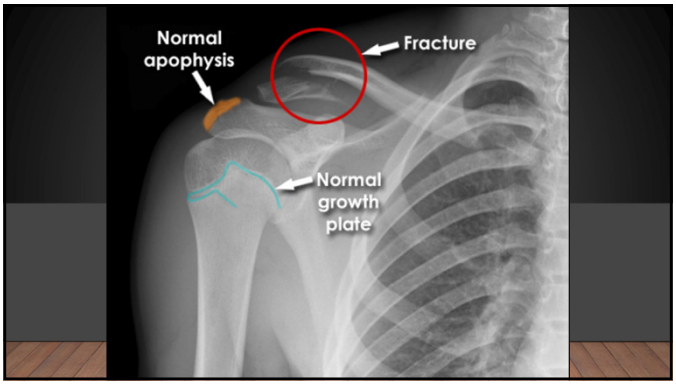

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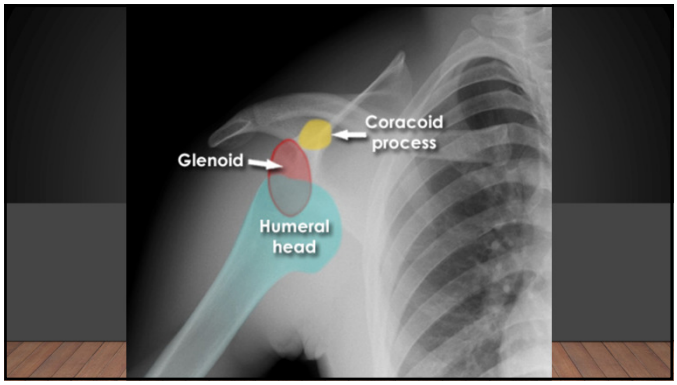

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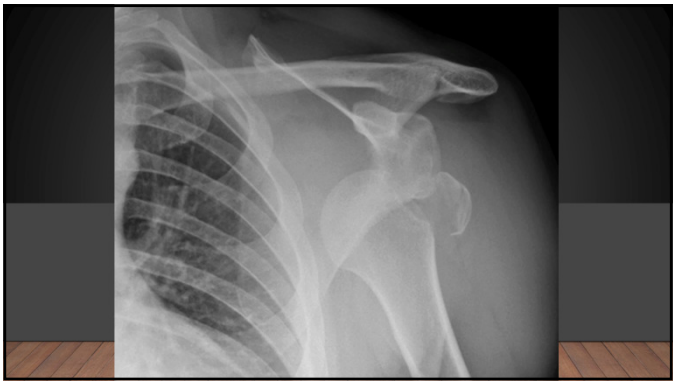

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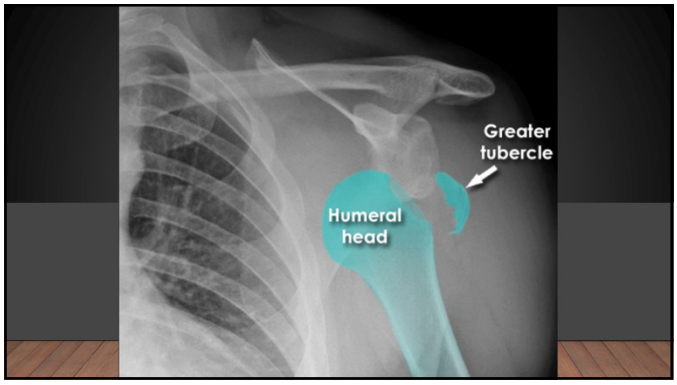

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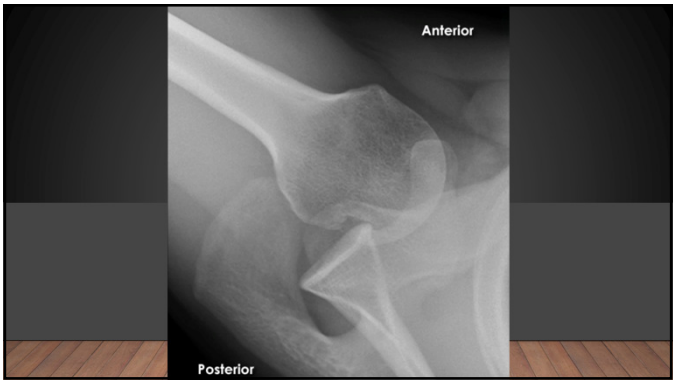

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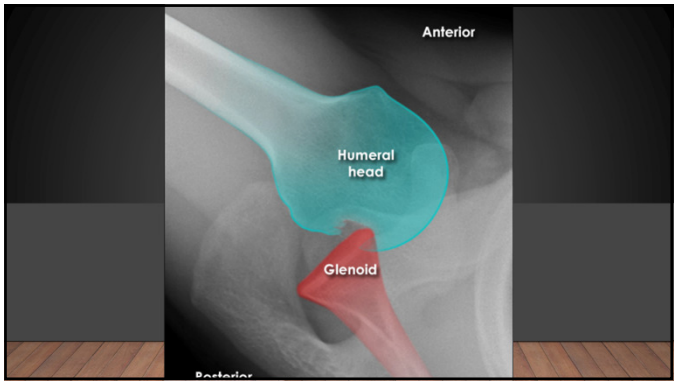

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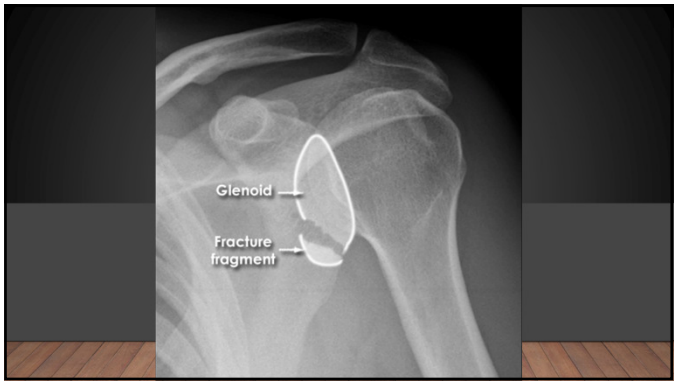

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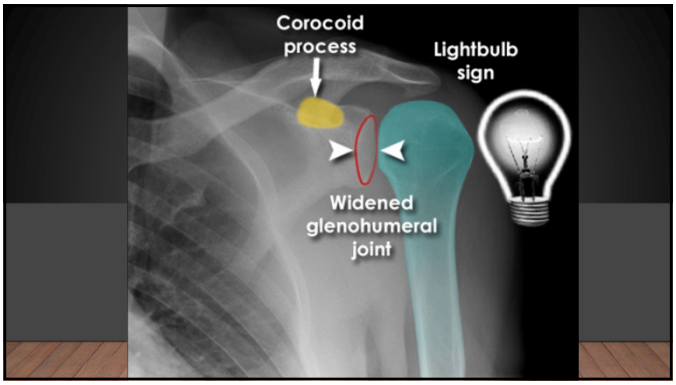

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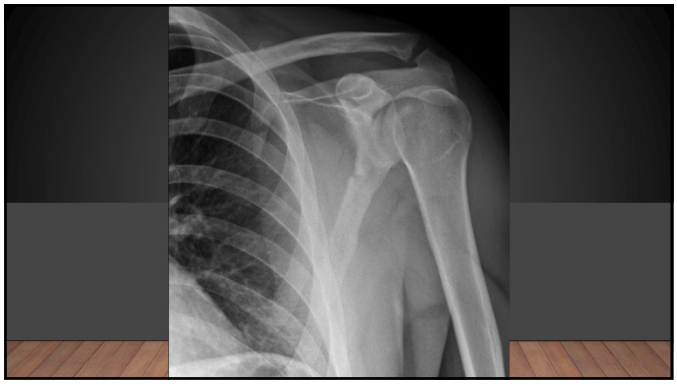

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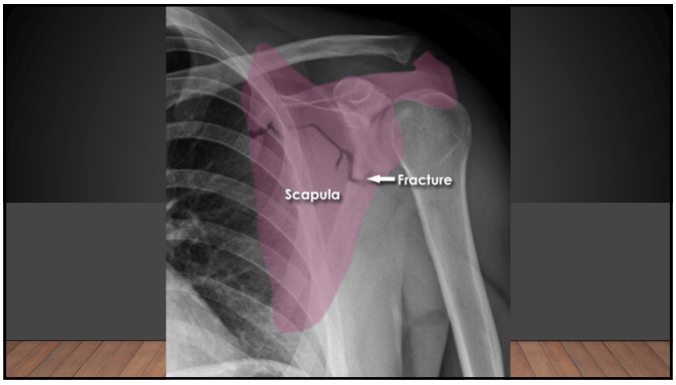

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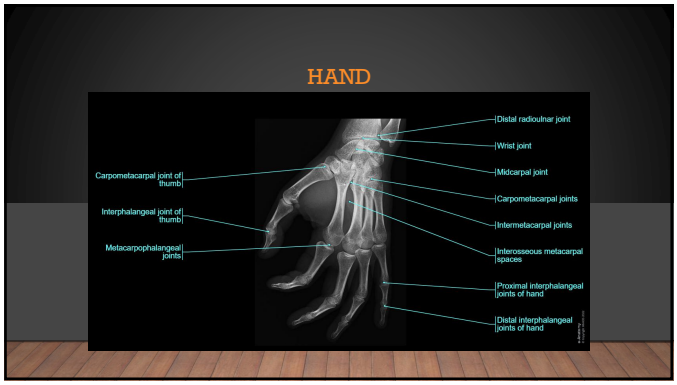

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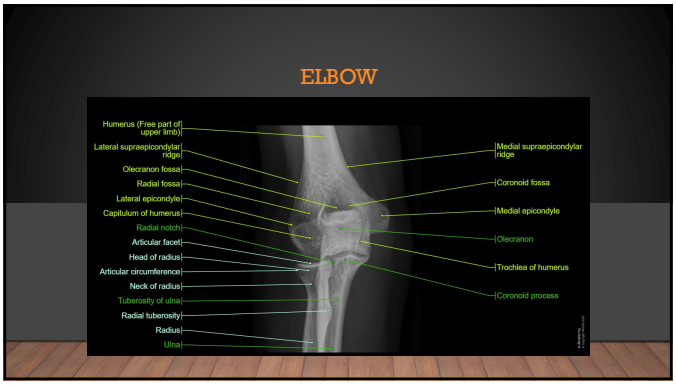

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CLASSIFICATION

- Intertrochanteric fracture
- Pertrochanteric: intertrochanteric, involving both trochanters
- Subtrochanteric fracture
- Greater trochanteric avulsion fracture
- Lesser trochanteric avulsion fracture
- Classification reference
- https://radiopaedia.org/articles/trochanteric-fracture?lang=us

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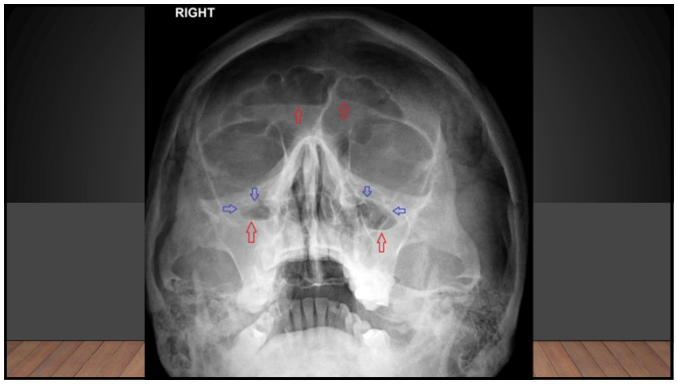

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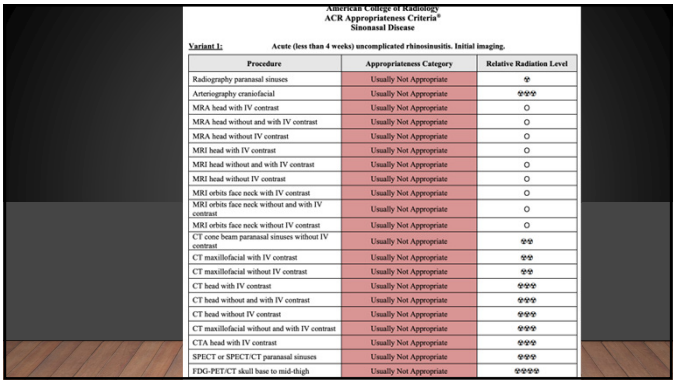

American College of Radiology
ACR Appropriateness Criteria®
Sinonasal Disease

Variant 1: Acute (less than 4 weeks) uncomplicated rhinosinusitis. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography paranasal sinuses	Usually Not Appropriate	☢
Arteriography craniofacial	Usually Not Appropriate	☢☢☢☢
MRA head with IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRI orbits face neck with IV contrast	Usually Not Appropriate	O
MRI orbits face neck without and with IV contrast	Usually Not Appropriate	O
MRI orbits face neck without IV contrast	Usually Not Appropriate	O
CT cone beam paranasal sinuses without IV contrast	Usually Not Appropriate	☢☢
CT maxillofacial with IV contrast	Usually Not Appropriate	☢☢
CT maxillofacial without IV contrast	Usually Not Appropriate	☢☢
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CT maxillofacial without and with IV contrast	Usually Not Appropriate	☢☢☢
CTA head with IV contrast	Usually Not Appropriate	☢☢☢
SPECT or SPECT/CT paranasal sinuses	Usually Not Appropriate	☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

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ACUTE RHINOSINUSITIS WITH SUSPECTED COMPLICATIONS

Variant 2: Acute rhinosinusitis with suspected orbital or intracranial complication. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without and with IV contrast	Usually Appropriate	O
MRI orbits face neck without and with IV contrast	Usually Appropriate	O
CT maxillofacial with IV contrast	Usually Appropriate	☢☢
MRI head without IV contrast	May Be Appropriate	O
MRI orbits face neck without IV contrast	May Be Appropriate (Disagreement)	O
CT maxillofacial without IV contrast	May Be Appropriate (Disagreement)	☢☢
CT head with IV contrast	May Be Appropriate	☢☢☢
Radiography paranasal sinuses	Usually Not Appropriate	☢
Arteriography craniofacial	Usually Not Appropriate	☢☢☢
MRA head with IV contrast	Usually Not Appropriate	O

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CT HEAD SUDDEN SEVERE H/A

Variant 1: Sudden onset severe headache that reaches maximal severity within one hour. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT head without IV contrast	Usually Appropriate	☢☢☢
CTA head with IV contrast	May Be Appropriate	☢☢☢
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢
MRA head with IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRV head with IV contrast	Usually Not Appropriate	O
MRV head without and with IV contrast	Usually Not Appropriate	O
MRV head without IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CTV head with IV contrast	Usually Not Appropriate	☢☢☢

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MIGRAINE H/A WITHOUT NEUROLOGIC SIGNS

Variant 2: Primary migraine or tension-type headache. Normal neurologic examination. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢
MRA head with IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRV head with IV contrast	Usually Not Appropriate	O
MRV head without and with IV contrast	Usually Not Appropriate	O
MRV head without IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CTA head with IV contrast	Usually Not Appropriate	☢☢☢
CTV head with IV contrast	Usually Not Appropriate	☢☢☢

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H/A WITH PAPILLEDEMA TINNITUS OR VISUAL SX

Variant 4: Headache with features of intracranial hypertension (eg, papilledema, pulsatile tinnitus, visual symptoms worse on Valsalva). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without and with IV contrast	Usually Appropriate	O
MRI head without IV contrast	Usually Appropriate	O
CT head without IV contrast	Usually Appropriate	☢☢☢
MRV head with IV contrast	May Be Appropriate	O
MRV head without and with IV contrast	May Be Appropriate	O
MRV head without IV contrast	May Be Appropriate	O
CTV head with IV contrast	May Be Appropriate	☢☢☢
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢
MRA head with IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CTA head with IV contrast	Usually Not Appropriate	☢☢☢

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LOW RISK C/P

Asymptomatic Patient at Risk for Coronary Artery Disease

Variant 1: Asymptomatic patient. Low risk for coronary artery disease. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT coronary calcium	Usually Not Appropriate	☢☢☢
US echocardiography transthoracic resting	Usually Not Appropriate	O
CTA coronary arteries with IV contrast	Usually Not Appropriate	☢☢☢
MRA coronary arteries without and with IV contrast	Usually Not Appropriate	O
MRA coronary arteries without IV contrast	Usually Not Appropriate	O
MRI heart function and morphology without and with IV contrast	Usually Not Appropriate	O
MRI heart function and morphology without IV contrast	Usually Not Appropriate	O
MRI heart function with stress without and with IV contrast	Usually Not Appropriate	O
MRI heart function with stress without IV contrast	Usually Not Appropriate	O
Radiography chest	Usually Not Appropriate	☢
SPECT or SPECT/CT MPI rest and stress	Usually Not Appropriate	☢☢☢☢
US echocardiography transthoracic stress	Usually Not Appropriate	O

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INTERMEDIATE RISK C/P

Variant 2: Asymptomatic patient. Intermediate risk for coronary artery disease. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT coronary calcium	Usually Appropriate	☢☢☢
CTA coronary arteries with IV contrast	May Be Appropriate	☢☢☢
MRA coronary arteries without and with IV contrast	Usually Not Appropriate	O
MRI heart function and morphology without and with IV contrast	Usually Not Appropriate	O
SPECT or SPECT/CT MPI rest and stress	Usually Not Appropriate	☢☢☢☢
US echocardiography transthoracic resting	Usually Not Appropriate	O
US echocardiography transthoracic stress	Usually Not Appropriate	O
MRA coronary arteries without IV contrast	Usually Not Appropriate	O
MRI heart function and morphology without IV contrast	Usually Not Appropriate	O
MRI heart function with stress without and with IV contrast	Usually Not Appropriate	O
MRI heart function with stress without IV contrast	Usually Not Appropriate	O
Radiography chest	Usually Not Appropriate	☢

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MILD ABNORMAL LIVER TRANSAMINASE

Variant 1: Abnormal liver function tests. Hepatocellular predominance with mild aminotransferase increase. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
US duplex Doppler abdomen	Usually Appropriate	O
US shear wave elastography abdomen	May Be Appropriate	O
MR elastography abdomen	May Be Appropriate	O
MRI abdomen without and with IV contrast with MRCP	May Be Appropriate	O
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
US abdomen with IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

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MODERATE TRANSAMINASE

Variant 2: Abnormal liver function tests. Hepatocellular predominance with moderate or severe aminotransferase increase. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
US duplex Doppler abdomen	Usually Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without and with IV contrast with MRCP	May Be Appropriate	O
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
US abdomen with IV contrast	Usually Not Appropriate	O
US shear wave elastography abdomen	Usually Not Appropriate	O
MR elastography abdomen	Usually Not Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

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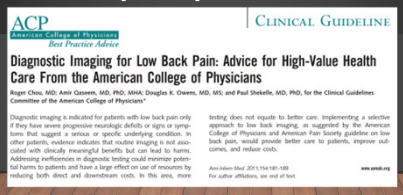
CONSERVATIVE ORDERING OF IMAGING OF SPINE

- More testing does not equate to better care.
- Implementing a selective approach to low back imaging
- Provide better care to patients, improve outcomes, and reduce costs


ACP American College of Physicians Best Practice Advice

CLINICAL GUIDELINE

Diagnostic Imaging for Low Back Pain: Advice for High-Value Health Care From the American College of Physicians

Roger Chou, MD; Amir Qaseem, MD, PhD, MHA; Douglas K. Owens, MD, MS; and Paul Shekelle, MD, PhD, for the Clinical Guidelines Committee of the American College of Physicians*

Diagnostic imaging is indicated for patients with low back pain only if they have severe progressive neurologic deficits or signs or symptoms that suggest a serious or specific underlying condition. In other patients, evidence indicates that routine imaging is not associated with clinically meaningful benefits but can lead to harms. Addressing inefficiencies in diagnostic testing could minimize potential harms to patients and have a large effect on use of resources by reducing both direct and downstream costs. In this area, more testing does not equate to better care. Implementing a selective approach to low back imaging, as suggested by the American College of Physicians and American Pain Society guideline on low back pain, would provide better care to patients, improve outcomes, and reduce costs.

Ann Intern Med. 2011;154:181-189. For author affiliations, see end of text. www.annals.org

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CHOOSING WISELY


Choosing Wisely®

Imaging for Low Back Pain

Recommendation

Don't do imaging for low back pain within the first six weeks, unless red flags are present. (Red flags include, but are not limited to, severe or progressive neurological deficits or when serious underlying conditions such as osteomyelitis are suspected.)

Low back pain is the fifth most common reason for all physician visits. Imaging of the lower spine before six weeks does not improve outcomes, but does increase costs.

Source: Agency for Health Care Research and Policy (AHCPR); Cochrane Reviews

"JUST SAY NO! IN FIRST 6 WEEKS UNLESS RED FLAGS"

- Severe or progressive neurologic deficits (e.g., bowel or bladder function, saddle parasthesia)
- Fever
- Sudden back pain with spinal tenderness (especially with history of osteoporosis, cancer, steroid use)
- Trauma
- Serious underlying medical condition (e.g., cancer)

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HOW TO SAY NO

- **Provide Clear Recommendations**
  - *"The good news is that based on your history and your normal physical examination I do not think that you need an x-ray."*
  - *"I would not recommend an x-ray at this point given these findings and the fact that except for having pain in the back from muscle spasm your examination is normal."*
- **Elicit Patient Beliefs/Questions**
  - *"What do you think is going on and what are you worried about?"*

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PROVIDE EMPATHY & OVERCOME BARRIERS

"I certainly understand that you want to get better?"

"I want to reassure you that your symptoms are very different from those of your brother or someone with a herniated disc"

"I want to be sure you are comfortable with this plan. I do not think you need a plain x-ray as they only show us the bones, which are unlikely to be the problem. A CT scan is not particularly helpful and exposes you to a lot more radiation. An MRI is the gold standard but the problem is that even in healthy patients we see abnormal discs so we are never sure that the finding on the MRI are related to your symptoms."

"There are things we can do to help your symptoms to help you feel better . Let's try this treatment and I will see you back in 6 weeks. If you develop any new symptoms like weakness in your legs, numbness or pain down the leg you should call me. However I expect like most people with low back pain you will start to feel better with the treatment."

Jensen MC, Brant-Zawadzki MN, Obuchowski N, et al. Magnetic resonance imaging of the lumbar spine in people without back pain. NEJM. 1994;331;69-73.

84

WHAT HAPPENS WITH INAPPROPRIATE TEST

- Can lead to additional tests, follow-up, and referrals
- May result in an invasive procedure of limited or questionable benefit
- As rate of spine MRI increased lumbar surgeries increased
- Expense
- Radiation Exposure

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CASCADE OF TESTING

- Following up on uncertain findings
- Study of 6000 patients who received an inappropriate X-ray or MRI for low back pain from 2017-2019
  - MRI were 14 percentage points more likely to have a cascade event
  - X-ray were 9 percentage points more likely than no imaging
- 30% of physicians report that they experienced cascades without a meaningful outcome on a monthly basis

Ganguli I. *J Gen Intern Med* 2022

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"LET'S TAKE A PEEK" IMAGING WHAT'S THE RISK ?

- All were **Asymptomatic** people
- 21% had spinal stenosis
- 17% had spine joint problems
- 19% had other abnormalities of the bones and tissues of the spinal canal
- Therefore, it is very hard to know if what you are seeing is actually what is causing the pain

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OPENING PANDORA'S BOX: PEOPLE SEE THEMSELVES AS SICK

- Pain Chronicity is influenced by Imaging
- Self-Perception of Damage
- Negative Message vs. Positive / Optimistic Message
- "I've got so many ruptured discs"
- "I am full of metal and screws"
- Adding to central sensitization

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SURGICAL INTERVENTIONS DO YOU HAVE TO BIOPSY?

- Imaging sometimes shows important issues which need addressing
- More often reveal issues which are self-limited
- Some are neoplastic but would never be life-limiting
- Can result in:
  - Biopsy or resection of lung granulomas
  - Liver, kidney, or adrenal incidental masses. Bx?
- Specialist tolerance of uncertainty?
- Much uncertainty in medicine with a tendency toward intervention
- Variation in surgical procedures performed over time

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INCIDENTAL FINDINGS

- 23.6% incidental findings with a higher frequency for studies involving CT than other imaging modalities
- 38% in research cohort
- Analogous to the results of screening tests when screening is applied to unselected, low-risk patients, and they generally result in low-value and potentially harmful care
- Examples
  - Adrenal Adenomas
  - Pulmonary Granulomas
  - Cysts of Liver, Kidney
  - Calcifications

Orme NM. *Arch Int Med* 2010
Ding A. *Radiol Clin North Am* 2011
Kwee TC. *Br J Radiol*. 2023
Davenport MS *AJR* 2023
Brady A *Eur Radiol* 2020

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FLEISCHNER SOCIETY SOLID PULMONARY 6-8 MM NODULES RECOMMENDATIONS

A: Solid Nodules*

Nodule Type	Size <6 mm (<100 mm³)	6–8 mm (100–250 mm³)	>8 mm (>250 mm³)	Comments
Single				
Low risk†	No routine follow-up	CT at 6–12 months, then consider CT at 18–24 months	Consider CT at 3 months, PET/CT, or tissue sampling	Nodules <6 mm do not require routine follow-up in low-risk patients (recommendation 1A).
High risk‡	Optional CT at 12 months	CT at 6–12 months, then CT at 18–24 months	Consider CT at 3 months, PET/CT, or tissue sampling	Certain patients at high risk with suspicious nodule morphology, upper lobe location, or both may warrant 12-month follow-up (recommendation 1A).
Multiple				
Low risk†	No routine follow-up	CT at 3–6 months, then consider CT at 18–24 months	CT at 3–6 months, then consider CT at 18–24 months	Use most suspicious nodule as guide to management. Follow-up intervals may vary according to size and risk (recommendation 2A).
High risk‡	Optional CT at 12 months	CT at 3–6 months, then at 18–24 months	CT at 3–6 months, then at 18–24 months	Use most suspicious nodule as guide to management. Follow-up intervals may vary according to size and risk (recommendation 2A).

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FLEISCHNER: SUBSOLID NODULES

B: Subsolid Nodules*

Nodule Type	Size <6 mm (<100 mm³)	Size ≥6 mm (>100 mm³)	Comments
Single			
Ground glass	No routine follow-up	CT at 6–12 months to confirm persistence, then CT every 2 years until 5 years	In certain suspicious nodules < 6 mm, consider follow-up at 2 and 4 years. If solid component(s) or growth develops, consider resection. (Recommendations 3A and 4A).
Part solid	No routine follow-up	CT at 3–6 months to confirm persistence. If unchanged and solid component remains <6 mm, annual CT should be performed for 5 years.	In practice, part-solid nodules cannot be defined as such until ≥6 mm, and nodules <6 mm do not usually require follow-up. Persistent part-solid nodules with solid components ≥6 mm should be considered highly suspicious (recommendations 4A–4C).
Multiple	CT at 3–6 months. If stable, consider CT at 2 and 4 years.	CT at 3–6 months. Subsequent management based on the most suspicious nodule(s).	Multiple <6 mm pure ground-glass nodules are usually benign, but consider follow-up in selected patients at high risk at 2 and 4 years (recommendation 5A).

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INCIDENTAL ADRENAL ADENOMAS

- Adrenal lesion, >1 cm, on radiologic examination done for reasons other than to investigate for primary adrenal disease
- Distinguish adrenocortical carcinoma, pheochromocytoma, primary aldosteronism, and Cushing's syndrome (which require surgical removal) from benign adenomas (which can be followed clinically).
  - >80%, are benign in nature

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COMMUNICATION TO RADIOLOGIST

- Patient Clinical Scenario
- Presumed Diagnosis
- What needs to be ruled out
- Urgency
- Contraindication (eGFR, coagulation)

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COMMUNICATION FROM RADIOLOGIST

- "Clinical correlation recommended"
- To better image this mass, suggest CT
- To better image this mass, suggest MRI
- Possible fracture, suggest…

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RADIATION EXPOSURE

- Radiation exposure attributed to medical sources rose from 5% in the 1980s to > 50% by 2009
- CT scans constituting 25% of all radiation exposure despite a decrease in radiation per scan

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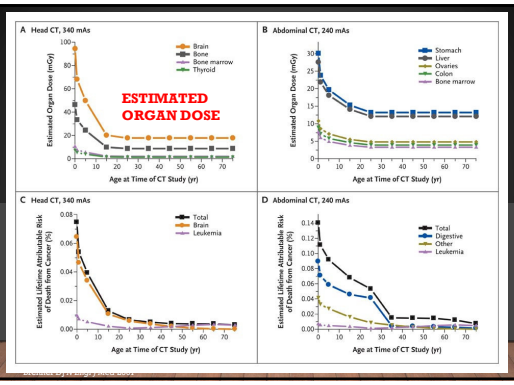

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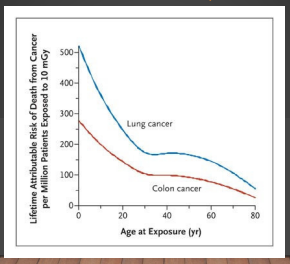
LIFETIME RISK OF CANCER PER MILLION PATIENTS EXPOSED (62M 2007)



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REDUCING CT SCAN RADIATION EXPOSURE

- Reduce the dose per study
- Reduce the number of studies
- Don't order a CT in the first place
  - Alternate imaging… U/S, MRI
  - Tolerance of uncertainty, don't have to test if situation is self limited
  - Try conservative options first

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RADIATION SAFETY

- Scientific unit of measurement for whole body radiation dose, called "**effective dose**," is the **millisievert (mSv)**
- Other radiation dose measurement units include rad, rem, roentgen, sievert, and gray
- Background Radiation 3 mSv
- CXR = 0.1 mSV = 10 days of background radiation

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RISK ESTIMATES

- Survivors of Radiation Exposure in WWII
  - Atomic bomb survivors ~ 40 mSv (approx. 3 CT scans)
  - 75-year longitudinal study
- Nuclear Industry
  - 400,000 radiation workers avg. dose 20 mSv
  - Quantitatively consistent with atomic bomb survivors
- Small individual risks applied to a population add up
- 1.4-2% of all cancers may be caused by medical radiation

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APPROXIMATE RADIATION DOSE

Procedure	Radiation mSv	Compare to Background years
CT Abd & Pelvis	7.7	2.6
CT Abd & Pelvis w & w/o	15.4	5.1
CT Colonography	6	2
IV Urography	3	1
Ba Enema	6	2
UGI with Barium	6	2
Lumbar Spine	1.4	6m
Extremity i.e., Hand	<0.001	< 3 hours
CT Brain	1.6	7m
CT Brain w & w/o	3.2	13m
CT H&N	1.2	5m
CT Spine	8.8	3y

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APPROXIMATE RADIATION DOSE

Procedure	Radiation mSv	Compare to Background years
CT Chest	6.1	2
CT Lung Ca Screening	1.5	6m
CXR	-.1	10 d
DEXA Bone Density	0.001	3h
Screening Digital Mammography	0.21	25 d
Screening Digital Breast Tomosynthesis 3D	0.27	33 d
CT Angiography	8.7	3
Cardiac CT for Calcium Scoring	1.7	6m
Non-Cardiac CT Angiogram	5.1	<2
PET CT whole body	22.7	7.6

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SUMMARY

- Consider the appropriate time for judicious use of diagnostic imaging
- Ensure you focus a clinical question for the radiologist, and perhaps even ask which study is most appropriate
- Don't reflexively order tests which are proposed in their interpretation
- Understand how intensely to follow up incidental findings
- If you are reviewing x-rays, have a methodological approach
- Be aware of radiation exposure risk which is proportional to age and have a way to discuss this with patients

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